DUNBAR (John R.W.)

AN ESSAY

ON THE

STRUCTURE, FUNCTIONS, AND DISEASES

OF THE

Nervous System.

By JOHN R. W. DUNBAR, A. M.
OF VIRGINIA.
RECORDING SECRETARY OF THE PHILADELPHIA MEDICAL SOCIETY.

"Non scribo hoc temere. Quo minus familiaris sum, hoc sum ad investigandum curiosior.—*Cic. ad Familiar. Epist.* xiii. *Lib.* iv.

To Revd Benjamin Kurtz
from the Author
Winchester
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DEFENDED BEFORE THE MEDICAL FACULTY

OF THE

UNIVERSITY OF PENNSYLVANIA,

MARCH 14, 1828,

FOR THE DEGREE OF

DOCTOR OF MEDICINE.

BY JOHN R. W. DUNBAR, A. M.

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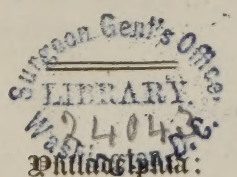

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TO

JOHN BELL, M. D.

LECTURER ON THE INSTITUTES OF MEDICINE, AND MEDICAL JURISPRUDENCE, IN THE PHILADELPHIA MEDICAL INSTITUTE, &c.

My Dear Sir:—

To no one can I dedicate this Essay with so much propriety as yourself: from you have I imbibed a taste for the subject, and to you am I indebted for many valuable suggestions with regard to the manner of treating it. But these are the least of the numerous favours which you have conferred on me, and I am proud to take the only means in my power of thus publicly expressing my acknowledgments. During the whole course of my professional studies, I have received from you the kindest attentions. Our relationship has not been the formal one of preceptor and pupil, but rather that of brother and of friend; and ever will it be my study to show a grateful sense of your kindness, although I can scarcely expect to make an adequate return.

Be pleased, Sir, to accept my best wishes for your health and happiness, and for your continuance in a prosperous advancement to the most elevated rank in our profession, which, in this country, sooner or later, is the reward of talents and industry such as you possess.

Your obliged friend,
And grateful pupil,
JOHN R. W. DUNBAR.

TO

PHILIP SYNG PHYSICK, M. D.

PROFESSOR OF ANATOMY, IN THE UNIVERSITY OF PENNSYLVANIA, PRESIDENT OF THE PHILADELPHIA MEDICAL SOCIETY, &c.

Sir: The feelings which prompt me to address you also on this occasion, are ambition and gratitude. The first of these sentiments is amply gratified by dedicating this Essay to the favourite pupil of the great Hunter, and the 'Father of American Surgery'—Nor am I less impelled by the second to present my thanks, for the kind and hospitable treatment I have received from yourself and family during my residence in this city. In the approbation you have been pleased to express of this production, I cannot but see an additional evidence of your kindness.

That you may continue a blessing to our country, and in the enjoyment of the pleasing reflections arising from the consciousness of a long and virtuous life, marked by the noblest achievements of our art, and the consequent alleviation of the miseries of your fellow men,

Is the ardent wish of

THE AUTHOR.

INTRODUCTION.

The present age is remarkable for the great advances that have been made in the Science of Medicine. The last century has almost entirely changed its character; reducing a mass of Galenical theory, and scholastic speculation, to regular philosophical system, based on the study of structure, and inductions therefrom. But in the wide range of Medicine, there has been nothing marked by greater improvement, than the study of the Nervous System. This, from its real or imagined connexion with mind, has always attracted the greatest attention. For more than two thousand years, from Aristotle to Gall, has it been the subject of continual study and meditation. The most celebrated geniuses in Medicine and Metaphysics, who arose and impressed the stamp of their minds on the doctrines of their age, all in succession applied their powers to explore the Egyptian darkness that hung over this subject. They felt the strong and elevating impulse of the superior *mind* with which they were gifted, and falsely imagined *it* competent to explain its own essence, and wonderful operations. Many were the hours devoted to investigations into the structure of its material organ, and still more numerous were the volumes composed in attempts to explain the uses of the different parts of this structure. Hence the unmeaning jargon on the *fiberkies* of the brain, the vibratory cords, and the animal spirits, which were so often, and ingeniously repeated, that their inventors at length came to the belief, that by the changes rung on these words of magical sound and but

little import, they had unfolded the mysteries of nervous action. But notwithstanding all their efforts, they more deeply involved the subject, and it has been reserved for our age, and for the last thirty years of it, to make greater advances in the study of the nervous system, than was accomplished in the many centuries preceding.

Among those to whom we are most indebted for their researches into this subject, are the names of Reil, Gall, Spurzheim, and Tiedemann, in Germany; Rolando and Bellingeri, in Italy; Magendie, Flourens, and Serres, in France; and Mr. Charles Bell, in England.

To give a digest of the present state of our knowledge of this system, as derived from their labours, is all at which I aim. I shall endeavour in my attempts to attain this end to reject entirely all theoretical speculations, and confine myself strictly to the relation of what is confirmed by experiment and the observation of pathological changes.

The great desire which I feel to understand this subject has influenced me to choose it as the theme of my Inaugural Dissertation, thereby obeying the injunction of the celebrated Dr. Johnson, "That if a man wished to understand a subject well, he should write a treatise on it."

INAUGURAL DISSERTATION

ON THE

STRUCTURE, FUNCTIONS, AND DISEASES

OF THE

Nervous System.

By the Nervous System is understood to be that peculiar matter of animals, which subserves the important purposes of receiving and transmitting impressions, whence arise sensations, and of performing the functions of intellect.

Physical Appearances of the Nervous Tissue.

Observed in the more perfect animals and in its larger or central masses, we find this tissue to be composed of two substances, differing in colour and consistence; viz: the *gray*, *cortical* or *cineritious*, and the *white*, *fibrous*, or as it has been improperly called the *medullary*. The cords called nerves, are composed of a number of minute sheathes of a cylindrical form filled with white pulpy matter, and contained in a tube called neurilema, which is hardened by the action of alcohol and acids. The principal marks of difference between the white and the gray matter are as follows:

The white or proper nervous portion, examined in its most perfect and recent state, after having been hardened by the action of heat and certain chemical substances, and carefully scraped with a blunt instrument, presents the appearance of fibres of a considerable magnitude, with furrows between them. It was this fibrous structure upon which the celebrated French philosopher Descartes founded a great part of his hypothesis of the animal spirits. These fibres are so ar-

ranged as generally to converge to the base of the brain, and it has been questioned whether they unite, forming the commissures, or whether they decussate and pass to the opposite sides of the body. The fact of paralysis occurring on a different side of the body from that of the brain which is injured, would seem to lend support to the latter of these opinions. The gray matter is of a reddish brown colour, of a softer consistence than the white, and in the fœtus bears a greater proportion to the latter than in after life. It evidently contains a great number of blood vessels, and was even maintained by the German anatomist Ruysch to be composed entirely of these with their connecting cellular membrane. It has been asserted by Malpighi that the office of this part is glandular, an opinion advocated by Gall and Spurzheim, who contend that the gray or cortical matter is the "origin and aliment of the white or nervous fibres, by means of which they are reinforced and nourished." With regard to the arrangement and proportion of these two kinds of matter in the nervous masses, we find that the white is in the greatest proportion, and generally occupies the internal part, except in the spinal marrow, where it is external. It predominates almost entirely in the nerves. The gray matter forms a layer of variable thickness on the outside of the brain, but is found also in the interior; sometimes it appears mixed with the white, or they are placed upon one another in alternate layers.

In the ganglia of the sympathetic, the white and gray matters are blended: this appearance joined to a particular physical arrangement of nervous filaments has induced Gall and Spurzheim to extend the term ganglion to those parts of the brain, such as the corpora striata, and of the spinal marrow at its lateral bulging, where the white and gray are intermixed.

Chemical Composition.

The chemical properties of the nervous matter are peculiar, and unlike any of the other constituents of the body; though they are nearly the same in whatever part of it they may

be found. To Vauquelin we are indebted for the latest and most correct analysis of nervous matter. From his experiments it appears that it is a peculiar chemical compound, resembling in some respects a saponaceous substance, and forming an emulsion with water. Its basis is albumen which can be partially coagulated by heat and acids; by the latter of which tests we discover its existence in vegetables. The other constituents are, reddish fatty matter, white fatty matter, osmazome, phosphorus, acids, salts, sulphur, and water. The water, albumen, and whitish fatty matter, are in the greatest proportion.

Intimate Structure.

The intimate structure of nervous matter is found by the experiments of Bauer to consist of innumerable small globules of a cellular texture, and arranged into rows of considerable length forming fibres: their average size is $\frac{1}{3200}$ part of an inch, and they are united by a transparent viscid mucus. The principal differences in the nervous structure consist in the size of the globules, and in the quantity of their viscid mucus. The gray part of the cerebrum and cerebellum is formed of smaller globules, the mucus is more abundant, and the fibres are much less distinct, than in the white portion.*

This structure is found to prevail nearly the same in all animals, even the lowest in the scale of vitality; and it has been asserted by a late eminent French writer (Dutrochet) that nervous matter exists to a certain extent in vegetables, particularly those of the mimosa tribe. As the subject is entirely new and very interesting, I shall devote a few pages to an analysis of his views as presented in his work,† and shall arrange them under the head of Nervous System of Vegetables; premising Dr. Dutrochet's first views and experiments, which were contradicted by some of his succeeding ones.

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* Home's Comparative Anatomy, vol. iii. p. 37.

† Recherches Anatomiques, et Physiologiques, sur la Structure Intime des Animaux et des Vegetaux, et sur leur Motilité. Paris, 1824.

Nervous System of Vegetables.

There is a remarkable analogy of structure between the medullary cellular tissue of vegetables and the substance of the brain of the Mollusca. The globular corpuscles in both are concrescible by acids and rendered soluble by alkalies. The arrangement of globular cells on the sides of which are the whitish corpuscles is nearly the same in both. The analogy is rendered still more striking in those vegetables endowed with irritability. Led by microscopical examinations and the effect of chemical re-agents on the minute globular bodies of the cellular tissue of vegetables, Dr. Dutrochet has called those concrescible by acids, *nervous corpuscles.* The leaves of the sensitive plant are attached to a long petiole, at the base of which is a swelling part designated by the term *bourrelet.* Similar but smaller enlargements exist at the insertion of the *pinula* in the summit of the petiole, and at the insertion of the leaflets into the *pinula.* In these, says the author, resides the moving power of the leaves of the sensitive plant, and in the parenchyma of the *bourrelet* or enlargement of the petiole, is a great number of nervous corpuscles; to exhibit which we must immerse a leaf of this plant in nitric acid, of the temperature of boiling water, for a minute only, and then remove it immediately into pure water. By this operation the leaflets become very transparent, and allow us to perceive by the aid of a microscope, the innumerable nervous corpuscles which have now become opaque; they are extremely minute and grouped around the vessels traversing the leaflets. The minute ramifications of these vessels loaded with the globular corpuscles resemble precisely a vegetable loaded with fruit.

Dr. Dutrochet thinks that the movements in vegetables, usually referred to their irritability, are in fact accomplished by two distinct powers and kinds of organization. To prevent the confusion which has arisen from the use of the words sensation and sensibility in physiology, he proposes that the

phenomenon produced by the impression of external agents on a vital surface, and transmitted by the nerves or nervous tissue, receive the name of *nervimotion*, and while vital property, in virtue of which it takes place, is termed *nervimotility*.

Nervimotility he conceives to be purely a physical phenomenon, which constantly precedes the moral one of sensation; but is not always followed by the latter. Hence our internal organs possess nervimotility; they experience nervimotion; but sensation does not thence result as is the case in our external organs or senses.

The power of executing visible movements, by which parts are displaced, may receive the name of *locomotility*. But this is always preceded by another invisible motion or power of experiencing certain modifications, by the influence of particular external agents called *nervimotors;* the faculty itself being nervimotility.

Dr. Dutrochet has proved by a number of delicate and ingeniously devised experiments, that in the sensitive plant (*mimosa pudica*) and indeed in vegetables generally, the two powers of nervimotility and locomotility are distinct and independent, and evidenced by correspondingly distinct organs. In some experiments he found that by removing the cortical parenchyma of the *bourrelet*, the petiole entirely lost the power of moving, without however the life of the leaf being destroyed. This in connection with other experiments shows that the locomotive structure does not prevail throughout the plant, but is limited to a part of the *bourrelet*. Whereas the nervimotility is diffused throughout the plant, and is called into action by the influence of an external agent. Thus if the sun's rays be directed through a lens on a single leaflet, this immediately bends towards its fellow; the neighbouring ones then meet each other, and the movement is communicated *gradatim*, from above downwards to the base of the *pinula* which bears these leaflets: the other *pinulæ* then bend to each other, and the movement is communicated as before, until

after a certain time the petiole bends. Nor is this all; the other leaves of the branch, above and below the leaf which has been burned, are also thrown into motion successively, and the folding of their *pinulæ* and leaflets succeeds the flexion of their petioles.

There is then evidently displayed a vital phenomenon, anterior to locomotion, and subsequent to the influence of the external cause. This phenomenon is nervimotion, a vital movement invisible, and appreciable only by its effects. To show still farther the diffused nervimotility of the plant, it is only necessary to direct a burning glass on the flowers of the *mimosa pudica:* no external movement is evidenced in them or in their long common peduncle, yet nervimotion is produced; for after the lapse of some moments the leaves of the branch are seen to incline to each other.

Nervimotility does not belong exclusively to the different parts of the stalk of the sensitive plant; the roots also participate in it, as is proved by the following experiments performed by Desfontaines: "If the roots of the mimosa be sprinkled with sulphuric acid, we soon see the leaves of the stalk incline to each other in regular order; those nearest the root beginning first; and then the next, and so on to the end of the plant."

Dr. Dutrochet found, however, on continuing his experiments, that the bark of the plant did not convey the impression of stimuli, or give rise to nervimotion; nor had the medulla such conducting power, but, the organs of this transmission were the ligneous parts of the plant. He draws the conclusion (p. 75-6) that all the portions of the central system which have tubes fitted for the transmission of the sap, are likewise fitted to transmit nervimotion, and between the two processes there is an exclusive and inseparable connexion. There is then, he continues, no doubt but that the transmission of nervous power in the sensitive plant is performed by means of the fluid of the sap. The nervous corpuscles are foreign to this transmission, although they are the generating organs of this power, by means of the influence of nervimotor agents.

The chief exciter of the motility of plants is solar light; so that *insolation* for them is what *oxygenation* is for animals: and *etiolation* has the same bad effects on the former as *asphyxia* on the latter.

ANATOMICAL DIVISION OF THE NERVOUS SYSTEM.

The nervous system is divided anatomically into three grand parts. 1st. The Peripheral, consisting of the nerves, and their membranous expansions: 2d. The Central or Encephalo-Spinal portion, composed of the encephalon and spinal marrow: 3d. The Ganglia or Sympathetic.

It is my intention only to consider the two first divisions, as my limited space prevents any details respecting the last. For the same reason I shall not enter minutely into the anatomy of the nervous system, but dwell more particularly on the functions which it performs.

The nervous system, functionally considered, has been arranged under the two general heads of that for animal and that for organic life. Under the first we class the encephalo-spinal mass, and its ramifications or pairs of nerves; and under the latter, the ganglia, plexuses, and branches of the sympathetic. The former presides over sensation, voluntary motion, and volition, and the latter over nutrition. The animal system is marked by its symmetry and duplicity, and seems to be made of two equal parts in close juxtaposition. The ganglionic, like the organs to which it is distributed, is distinguished by irregularity and want of symmetry.

Formation and Growth of the Nervous System.

In considering the formation of this system in the different orders of animals, we shall find that in the lowest it is very simple, consisting of but mere nervous globules, distributed through an amorphous pulpy mass. As we ascend in the scale, this structure is found arranged successively into

ganglia; then into ganglia and a longitudinal or spinal cord running the length of the body; and lastly into ganglia, spinal cord, and brain or encephalon, each becoming more perfect as we ascend in the scale of animated creation.

The order of development would seem to be from without inwards in the route of sensations, and I shall pursue this course in treating of structure and functions.

Of the Nerves.

The nerves, according to Serres, are formed simultaneously with the organs in which they are found, and of these the first formed are, the lateral nerves of the trunk, the head, and the pelvis: they have attained their growth when the encephalon and spinal cord are yet liquid, and have not assumed their primitive forms. That their formation is independent of the central portion is evidenced by their isolation from it, and by their complete development in acephalous and other fœtuses, which are born without a spinal cord.

The old division of nerves into cerebral and spinal is not only arbitrary but incorrect. Anatomists have now clearly demonstrated that, with the exception of the olfactory, all may be traced to the long nervous cord artificially divided into medulla oblongata and spinalis. In this respect as well as in some other parts of this subject, we would seem, until late years, to have retrograded rather than advanced. Bartholinus, whom I shall quote more particularly hereafter, says expressly: "The use of the lengthened and spinal marrow, is to be the original of all the nerves; for from that part thereof within the skull, those nerves arise which are commonly attributed to the brain, being usually reckoned to be seven pair; but from the longest part thereof, which is the backbone, anatomists do reckon thirty pair of nerves to arise, viz. as many as there are holes in the vertebræ."

Functions of the Nerves.

The uses of the nerves appear to be to connect the percipient centre with external objects, in other words to convey the impressions made on the surfaces of relation, and transmit the commands of the centre to the muscular system. The principal phenomena in which they are instrumental take place at their two extremities, viz. the peripheral and the encephalic. The peripheral portion is expanded into very minute fibrils, and even according to a late writer into membrane. He asserts "that he has traced the nerves in many parts of the body until they have appeared to terminate in a very delicate membrane, which was found on investigation with a glass to consist of a plexus of very minute nerves;" the impression made on this membrano-nervous expansion is conveyed along the intermediate portion to the central termination, where the peculiar phenomena take place.

The labours of contemporary physiologists have shown that there are two kinds of nerves, viz. those for sensation or feeling; and those for motion. It was maintained by some of the older anatomists that this difference in office was not owing to a peculiar property of sensitivity or motivity possessed by these two orders of nerves, but from the variety in their distribution. Thus, if implanted into muscles, the organs of motion, they are termed *motive* or *motor* nerves; if into instruments of sense, *sensitive* nerves; sometimes also one pair of nerves may have both of these functions, as the par vagum, for instance, which is distributed to the viscera of the chest and abdomen to cause the sense of feeling; and when it becomes recurrent it bestows motion on the muscles of the larynx.

Anatomists have at all times separated the nerves of the four senses, from those appropriated to touch or feeling; they also regarded the third, fourth, and sixth pairs, as destined to motion, but they supposed all the other trunks of the medulla,

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* Swan. *Observations on the Nervous System*, p. 3d. London, 1822.

oblongata, and spinal cord to pertain to feeling and motion indiscriminately. We are indebted to Mr. Charles Bell for having within the last few years, by his researches into this subject, cleared up much of the uncertainty which enveloped it.

By this gentleman two general divisions of the nerves have been made, as regards their function.* These are, 1st. the symmetrical, 2d. the irregular or superadded. Under the first head are comprised the sensitive and motor nerves; under the second, those which unite the body in the functions of growth and decay, and the respiratory nerves. Although these last may very properly be considered under the first division; yet, in order to prevent confusion, I shall consider them in the order classed by Mr. Bell. I shall enumerate in a succinct manner the particular nerves which belong to these divisions; and then speak of the functions of each.

Sensitive Nerves. These are, the Olfactory, Optic, Auditory, or Portio mollis; the Trigeminus or fifth, all the Spinal nerves, which originate from the posterior column of the spinal marrow.

Motor Nerves. These are, Motores Oculi, Pathetici, Motores Externi, Facial or Portio Dura, Accessory, Glossopharyngeal, Hypoglossal, and all the Spinal nerves which originate from the anterior column of the spinal marrow.

Respiratory Nerves. These are, the 4th, 7th, Glossopharyngeal, Spinal accessory, Phrenic, and Par Vagum, and all the fibrils of the Spinal nerves, which originate from the lateral column of the spinal marrow.

I shall first speak of the nerves of the two classes which have their origin within the cranium.

Of the Sensitive Nerves.

The *Olfactory* originates from the basis of the brain in the fissure of Sylvius, and is expanded on the lining membrane

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* Exposition of the Natural System of the Nerves of the Human Body. Philadelphia, 1825.

of the nostrils: its function is to take cognizance of those qualities of bodies called odours.

The lesions of this nerve produce corresponding alterations in the sense, by which it is rendered either acute or obtuse, or entirely destroyed. This last state is called *anosmia*, and is mostly a symptomatic affection.

Optic. This nerve is generally described by anatomists as originating from the Thalamus Nervi Optici; but the late observations of Gall and Spurzheim, confirmed by Tiedemann and Serres, show it to arise on each side from the Tubercula Quadrigemina. According to Serres, "These bodies are developed in all the classes, and in every family of each class, in a direct ratio with the optic nerves and the eyes. Fishes have the largest quadrigeminal tubercles and the most remarkable eyes and optic nerves." The originality of this assertion has been supposed to be due to Drs. Gall and Spurzheim: but the following passage from Bartholine proves that it was not unknown to him. Speaking of the origin of these nerves he says, "They arise not, as the common opinion is, from the forepart of the basis of the brain, for their original must be sought further towards the hinder part of the head, where they are carried between the brain and the beginning of the spinal marrow, and *arise out of the beginning of the first trunks* of the Medulla Oblongata, growing out of the brain. But Riolanus demonstrates that they are turned round about those great eminences of the brain which Galen calls Thalamos nervorum opticorum, which reach unto the foremore ventricles to fetch optic spirits from thence." p. 324.* In a previous passage he styled the nates and testes the roots of the Medulla Oblongata. A very interesting case related by Dr. Bond of this city, offers strong confirmation of the origin of this nerve, "During life the sight was destroyed, and examinations after death discovered that the place which is usually occupied by

* Bartholinus' Anatomy, made from the Precepts of his Father, and from the Observations of all Modern Anatomists, together with his own. Published by Nich. Culpepper, Gent. and Abadiah Cole, Doctor of Physic. London 1668. pp. 377.

the tubercula quadrigemina was filled by an abscess containing a large quantity of straw coloured fluid; and what is worthy of remark, the Thalami appeared to be unaffected."* The development of the optic nerve is always in proportion to the perfection of the sense, a noted instance of which is met with in the eagle. The lesion of this nerve is atrophy constituting the disease called *amaurosis*. In a case of this nature a small tubercle was found, after death, developed in the optic nerve.

If, as above asserted, the corpora quadrigemina are merely parts of the medulla oblongata, the optic can no longer be considered as cerebral nerves. The olfactory will in fact be the only one allowing of this name. The changes that have occurred in the enumeration of the origins of the nerves, are worthy of note. Anatomists of the present day reckon only one; the older writers mention seven *cerebral* nerves, which they comprehended in the following verse.

> Optica prima, oculos movet altera, tertia gustat
> Quartaq; quinta audit, vaga sexta est, septima linguae.

Thus quaintly translated.

> "First sees, next moves the eyes; third, fourth, do taste;
> Fifth hears, sixth roams, seventh moves the tongue too fast."

From this it will be seen that their enumeration differed from ours, and that they omitted the only pair which are now considered as cerebral nerves.

Auditory. The nerve which presides over the sense of hearing is the portio mollis, a branch of the seventh. It originates from the medullary striæ, on the surface of the calamus scriptorius, and also from the corpus restiforme, between the glosso-pharyngeal nerve and the Tuber Annulare. It is distributed to the lining membrane of the cochlea and labyrinth generally. It forms the immediate organ of hearing.

Disease of this nerve, causes diminished hearing, tinnitus aurium, or total deafness.

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† North American Medical and Surgical Journal, Vol. V. See Dr. Bond's Case, page 65.

Trigeminus or Fifth. This is one of the most interesting nerves to the physiologist. It originates from the side of the pons Varolii, just where it is continuous with the crus cerebelli, and divides into three principal branches; viz: the Supra Orbital, the Superior, and the Inferior Maxillary. It is distributed to every part of the face, to the muscles of the forehead, the eye lids, nose, lips, &c.: it communicates with the organs of all the five senses, and their voluntary muscles; and brings these and other parts of the body into mutual relationship.

Functions.—On comparing the opinions of different physiologists, particularly Charles Bell, Magendie, and Mayo, it appears that this nerve presides over the sense of touch as diffused over the whole face; and by means of its gustatory branch conveys the sense of taste. It has an evident influence over the organic functions of the eye, the tongue, the gums, and the motions of the iris. It is also found by Mr. Bell to be a muscular nerve, as excitation of the roots in an ass recently killed, made the jaws to snap violently together, whilst after their division the jaws fell. Lately it has been maintained by M. Bellingeri* that the large and small portions of this nerve are as essentially distinct in their functions as two differont nerves. His ideas on the subject are in some respects at variance with those advanced by Mr. Bell. The larger portion, in his opinion deduced from its origin, ganglionic structure and distribution to the lachrymal and other glands, maxillary sinuses and other parts, is destined for the organic functions of the face; and hence that it gives rise only to involuntary movements, as those in the iris, and those that take place in the newly born infant in the act of sucking. The smaller portion he regards, in common with Mr. Bell, as bestowing the power of voluntary movement on the parts to which it is distributed, and not to the sense of touch; and as it is destined to mastication, he proposes to call it the *masticator* nerve. He does not think that the trigeminus presides over taste, which he regards as pertaining to animal life.

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* Journal des Progrès, des Sciences, et Institutions Medicales, page 27 to 35, Vol IV. 1827.

The principal affection of this nerve is Tic Douloureux; it is also liable to other affections, an interesting case of which is related by Serres. A young man was affected by a slight ophthalmia of the right eye, which increased gradually, the cornea becoming opaque, and the sight decaying until finally destroyed: the other organs of sense and motion on the same side were successively paralyzed; the eye, eyelid, nostril, and half of the tongue lost their powers, whilst on the left they remained perfectly unaffected. Post mortem examination discovered the following appearances: first, an organic change of the ganglion of the fifth pair; it was enlarged, of a yellow colour, and vascular below: second, a conversion of the nerve itself, at its insertion into the annular protuberance, into a yellow gelatinous looking matter, similar to the ganglion, and penetrating, in little processes, the substance of the protuberance in the direction of the nervous insertions. The muscular branches of the nerve were, however, found healthy on the otherwise affected side; the process of mastication, therefore, had never been injured.*

Sensitive Spinal Nerves.—Under this head we include the fibrils which originate from the posterior column of the spinal marrow; they shall be treated of when we come to speak of this latter.

Motor Nerves.

Motor Oculi, or *Third.*—This nerve originates from the internal face of the crus cerebri, a little in advance of the anterior margin of the tuber annulare. It is distributed to the muscles moving the eye in general. In function it is a voluntary nerve, directing the eye to objects, and has been proved by Magendie not to convey sensible impressions.

Trochlearis, Patheticus, or *Fourth.*—It originates from the upper and anterior face of the valve of the brain, just below the testes. It is distributed to the superior oblique muscle of

* Spurzheim's Anatomy of the Brain, translated by R. Willis, p. 42.

the eye, and has the office of combining the motions of the eyelid and ball. "It has no prerogative over the other nerves of motion in expressing the affections and passions; the name *patheticus*, or ogling nerve, therefore, which it has obtained, is misapplied. Although a nerve of motion, it arises from the dorsal surface of the nervous mass."

Motor Externus, or *Sixth*, originates from the upper extremity of the corpus pyramidale, under the posterior margin of the tuber annulare, and is distributed to the abductor oculi. Its function is to regulate the voluntary motions of the eye by means of this muscle.

The *Facial Nerve*, or *Portio Dura*, of the 7th, has its origin from the superior and lateral parts of the medulla oblongata, close to the nodus cerebri, just where the crus cerebelli joins the medulla oblongata. It forms two communications with the trigeminus, the vidian nerve, and the chorda tympani, and in fine communicates freely with all the three branches of the 5th: it resembles in texture the par vagum, its filaments being very closely connected. The distribution is to the muscles of the whole face, the superficial muscles of the throat, and the muscles of the velum and back part of the palate. The functions of this nerve are to preside over the movements of the parts just enumerated; it has little power of conveying sensible impressions. All the parts supplied by it are instantly paralyzed if it is divided; and if pricked or irritated, they are thrown into convulsive contractions. When sensibility is evidenced, it may be attributed to some branches of the 5th blended with it. Cutting it asunder is productive generally of little or no pain, but is always followed by paralysis of the muscles of the face. Bellingeri regards this nerve as pertaining particularly to voluntary movements of the senses of animal life, but having no influence over either touch or taste.* We shall consider the connexion of this nerve with respiration, under the head of the respiratory nerves.

Hypoglossal, or *Ninth*, originates from the medulla oblon-

* Journal des Progres, ut supra.

gata, by several fasciculi placed one above the other, and is distributed to the muscles of the tongue. Its functions are to supply the tongue with motive power, in the acts of mastication, deglutition, speaking, singing, &c. Its power over the muscles of this organ is satisfactorily proved by an experiment of Mayo. He found that when the nerve was irritated in an animal recently killed, the tongue was convulsed; and when that of each side was divided, this organ became motionless. Fodera obtained similar results. It is a nerve of expression.

The *Eighth Pair.*—Under this term three different nerves have been included, viz: the Spinal Accessary, the Par Vagum, and the Glosso-pharyngeal. The consideration of the functions of these nerves will be taken up under the head of those of Respiration.

Motor Spinal Nerves.—These are all the nerves which originate from the anterior column of the spinal marrow, under which head I shall consider their functions.

I think it proper to introduce the outline of a very interesting case, from a late journal,* as it affords strong pathological illustration of the functions of several of the preceding nerves. The symptoms of the case were as follows:—Neuralgia of left side of the face at first, afterwards the pain diminished and was succeeded by a sense of cold, left lower eyelid depressed, but vision was complete; left side of the face and nostril paralytic; the sense of smell was entire; taste enfeebled, distinguishing nothing but sugar; deglutition difficult, food, on arriving at the pharynx, greater part rejected; voice was still formed, but speech nearly gone; motion of right side entire, body drawn into an arc of a circle. The left arm and leg had lost much of their feeling and motion, but were not quite paralyzed; the heart seemed occasionally to cease beating, and hence paleness of face and loss of thought. The respiration for a long time would become impeded and laborious. Dissection, performed twenty-four hours after death, exhibited the following appearances:—A tu-

* North American Medical and Surgical Journal, Vol. V. January, 1828, page 207.

mour of the size of an egg was discovered apparently developed between the arachnoid and pia mater, resting on the basilar surface, before the auditory foramen and the anterior condyloid foramen, occupying chiefly the tuber annulare; one prolongation compressed the gangliform enlargement of the trifacial or fifth nerve, the ganglion of which was atrophied; the internal border of the prolongation compressed the external motor nerve of the eye, the external carotid artery and ophthalmic branch. The common motor, and the pathetic and ophthalmic nerves, were united by a dense cellular tissue, which seemed to have been the seat of inflammation. The fifth nerve was directly under the tumour; its filaments were short and flat; its substance penetrated by many vessels. The left external motor of the eye was enlarged in the middle of the tumour. The facial, acoustic, and hypoglossal nerves, and those passing out by the left foramen lacerum, were compressed. The optic and olfactory were not injured. From the above account the following inferences are drawn by the reporters of the case—Drs. Jobert and Cazenave:—That the pains in the face, at first acute and afterwards diminishing, were referrible to neuralgia of the fifth, diminished subsequently by pressure of the tumour. Loss of taste arose from the altered condition of the lingual branch of the fifth. Immobility of the left nostril, and angle of the mouth drawn to one side, from compression of the left facial nerve. The difficulty of deglutition, and the derangements of the circulation and respiration, were probably owing to the pressure of the tumour on the glosso-pharyngeal, par vagum and spinal nerves. The slow and gradual abolition of speech was caused by pressure on the great hypoglossal nerves. The functions of sight and smell being in a natural state, so were the corresponding nerves. Of the preservation of the intellectual faculties corresponding with the integrity of the brain, I shall not speak in this place.

Of the Respiratory Nerves.

These nerves originate in a line from a distinct column of the

spinal marrow, from that tract of white or fibrous matter extending from between the corpora olivaria and restiformia down the lateral part of the spinal marrow, between the sulci which are the origins of the anterior and posterior roots of the spinal nerves. Their distribution is to such muscles only as are concerned in the subsidiary acts of respiration. In function, they are found to connect the internal organs of respiration with the sensorium, and to unite in common action the respiratory muscles.

Respiratory Nerve of the Eye (fourth of the head). Its function is to establish a relation between the eye and the extended respiratory system, as we see in bodily pain or anguish of the mind, in which the eyes are raised and dragged in correspondence with the alteration of the other features.

Respiratory Nerve of the Face (Portio Dura).—The function of this nerve is to associate all those motions of the nostrils, lips, and face generally, which correspond with the movements of the chest in respiration. C. Bell cut the portio dura of one side in a monkey; and having rendered the breathing laborious, he found that the movements of the nostrils and lips, which accompany that state, were confined to the sound side. If both sides were cut, all movements of expression and convulsive breathing were totally lost. This nerve, from its distribution to the lips and nostrils, furnishes to these parts the power of inhaling air, and is consequently intimately associated in function with the par vagum. Hence any unusual action of the muscles to which it is distributed, gives evidence of a laborious and morbid state of the lungs in respiration. This is displayed in certain thoracic affections, where the play of the nostrils in alternate dilatations and contractions, and the gaspings of the patient, indicate too truly the oppressed condition of the respiratory apparatus, in which state these symptoms are often of the most fatal diagnostic.

Superior Respiratory of the Trunk (Spinal Accessary), is distributed to the sterno-cleido mastoid and trapezius muscles, whose action is to raise the shoulders and chest, and to bring

together and fix the scapulæ. These movements are made involuntarily to assist in laborious respiration. If this nerve be divided in an ass, and on both sides, and laborious respiration be induced, they cease to act on that occasion, though they still serve as voluntary muscles.

Internal Respiratory (Phrenic). This nerve is distributed to the two surfaces and the muscle of the Diaphragm. Its functions are to preside over the movements of this part.

The *Inferior Respiratory Nerve of the Trunk* (External Thoracic), is distributed to the serratus major muscle. Upon this nerve Mr. Bell has not experimented, but he has observed in a case of fracture of the 6th and 7th cervical vertebræ, in which the whole body below the seat of the injury was powerless, that the abovementioned muscle acted with remarkable effort of the breathing, but not with any of voluntary motion.

The above, with the intercostal nerves, are those of simple respiratory actions and expression, alike interesting to the physiologist, the physician, and the artist. To illustrate their several influences, divide first the phrenic; the movements of the chest become more expanded, but unless the breathing is rendered forcible, none of the subsidiary muscles are called into action. Next divide the spinal cord at the bottom of the neck; the chest is fixed, but the muscles of the face are violently convulsed in ineffectual efforts to keep up respiration. Then divide the medulla oblongata, and the nostrils and lips alone are in motion.

But the nerves which preside over the simple and compound respiratory acts, are the Glosso-pharyngeal and Par Vagum, under the head of 8th pair, or Pneumo-Gastric. The distribution of the first, is to the tongue and pharynx, hence its name. The second goes to the larynx, trachea, lungs, and stomach. Their functions are to unite the muscles of the throat and larynx, with the other respiratory muscles, in Phonation or the voice, and in the acts of swallowing, coughing, and the like. The division of the laryngeal branch of the par vagum, stops the consentaneous action of the muscles of the glottis and those

of the chest: section of the recurrent branch destroys the voice: injury or compression of the nerve itself produces difficulty of breathing. But its peculiar function appears to be, to act as an internal sense, transmitting to the medulla oblongata, the central point of the respiratory nerves, the sensation of the want of air; and the influence issuing from that point causes the respiratory muscles to expand the nostrils, trachea, and thorax, in order to admit air to gratify this want. Without this nerve, all the other respiratory nerves are useless: it may be likened to the spring of a well contrived piece of mechanism,—until this is acted upon, all the other systems of wheels, &c. are motionless, and would so for ever remain. We see occasionally still-born children, who are so in consequence of the air passages being obstructed by mucus, and the air prevented from making the necessary impression upon the lungs, a state of things incompatible with the expansion of the chest; but breathing may be restored, if the accoucheur removes the mucus in time. The par vagum is distributed also to the stomach, in which we find it performing a part similar to that exercised in the lungs, and constituting what may be called a *gastric sense*, apprising the individual of the necessity for food, and of the nature of the ingesta when swallowed. "The communications by its means established, and its extensive distribution, explain the sympathies that exist between the throat, lungs, stomach, heart, &c." From the above account of the functions of the par vagum, it will be seen that it may with great propriety be ranked under the head of sensitive nerves.

It has been thought that some species of asthma and dyspepsia were caused by disease of this nerve. In a case related by Swan, "a patient had the functions of the stomach impaired from the use of colchicum taken for gout: he was eventually attacked with difficulty of breathing; and after death, the par vagum was found flabby and smaller than natural, like nerves removed from a putrid body, after having been soaked in water. The continuation of the nerves at the termination of the

œsophagus, was found redder than usual, and had not a healthy appearance."* We are also assured, that certain kinds of aphonia result from loss of power of this nerve, the muscles of the larynx not acting in the proper manner on the transmitted air, so as to produce voice.

PATHOLOGY OF THE NERVES IN GENERAL.

The most usual affections of a nervous cord, are as follows: I. *Inflammation.* This is seldom an idiopathic affection, but originates from proximity to inflamed parts The prominent symptom is acute pain, and the nerves are found upon dissection to be red, swollen, with a kind of varicose dilatation of their vessels; there is also an infiltration of gelatinous fluid.† They are subject to a species of chronic inflammation, occurring generally at their extremities, in the stumps of amputated limbs, in which case they enlarge in a manner similar to what takes place in the reunion of divided nerves. We are told that the least touch is so very painful to nerves thus affected, that patients are occasionally obliged to submit to a second amputation.

II. *Ulceration.* This may occur, but Beclard doubts whether ever as a primary affection.

III. *Tumours of Nerves* (*Neuromes.*) These are improperly called Ganglions, and are the most frequent alterations of the nervous tissue. They are distinguished into two kinds. 1. *Subcutaneous painful Tubercles.* These are oblong flattened bodies, varying in size from that of a grain of millet to a bean, and situated in the subcutaneous cellular tissue, most frequently of the limbs. They are generally enveloped in the cellular tissue, to which they are attached only by nervous fi-

* Dissertation on the Treatment of Morbid Local Affections of the Nerves.

† Descot. Dissertation sur les Affections Locales des Nerfs, page 195.

laments: they are whitish, and of a cartilaginous consistence; and do not generally project above the skin, but may be felt by applying a finger to the part indicated by the patient as the seat of the pain. Sometimes they are consequent on a wound; but it is difficult generally to assign a cause for their production. They are often the seat of agonizing intermittent pain, darting with electrical quickness into all the ramifications of the affected nerve. The best remedy is extirpation. 2d. *Voluminous, or multiplied tumours of the nerves.* These are generally a schirrous tissue, more or less firm, interspersed with small cysts, containing a fluid of syrupy consistence, similar to that met with in soft schirrus. They are generally moveable laterally without producing pain; but the case is different, if moved lengthwise. Unlike the preceding, they enlarge rapidly, attaining in some cases the size of an egg, and undergoing degeneration in their tissue, accompanied with great pain. Professor Dumeril, in a case of cancer, found the nerves evidently altered and swelled in all their branches.

IV. *Neuralgia** (*Tic Douloureux*). This is an affection of the nerves, attended with lancinating shooting pain, which intermits, and is unattended by redness, tension, or apparent swelling. It is located in the trunk or branch of a nerve, and appears to dart from the point first affected along all its ramifications, following them so accurately, that I have heard a distinguished physician of this city, who is much tortured by neuralgia of the lower extremity, say, that when labouring under an attack, he is enabled to trace, with anatomical accuracy, all the branches of the affected nerve, by the course of the pain. The nerves most subject to this affection, are the subcutaneous, particularly those of the face. It comes on most generally after cold, and is often found in individuals subject to gout and rheumatism. It is often caused by a small tumour or cancerous degeneration, which compresses or affects a nerve: sometimes the affected

* Dictionnaire des Sciences Medicales, Tome XXXV. article Neuralgia.

nerve is found enlarged and reddish; and in a preparation which was in the possession of the celebrated Bichat, the sciatic nerve, the seat of this affection, exhibited at its upper part a multitude of small varicose dilatations of the veins penetrating it. In a case in which Mr. Hunter divided a musculo-cutaneous nerve thus affected, he was obliged to use a ligature to stop the hæmorrhage. Every thing combines to induce the opinion, that this disease is only intermittent or remittent *Neuritis*.

V. *Local paralysis.* This is a total abolition of sensation and motion of any particular part, most usually the muscles of the face, and is usually dependent upon a local affection of the nerves, or it may be caused at any time by dividing those going to a part. Local paralysis of the face usually depends upon a simultaneous affection of the Trigeminus and Facial nerves; but either of them may be affected, and the other not; hence sensation may be destroyed and motion remain; and the reverse may occur, as in the case above quoted from Serres.

In addition to the above affections of the nerves, occasionally convulsions, epilepsy, tetanus and other neuroses, are developed from mechanical injury, inflammation, or finally from degeneration of a nerve. But the greater number of the cases of these affections, are dependent on some alteration of the nervous centres.

NOTE. With regard to the *Re-union* of divided nerves, it is now incontestibly proved that nerves which have been divided, if they remain in apposition, will unite, and that when thus united they are competent to the performance of their former functions. The latest writer on this subject is M. Prevost, whose experiments and conclusions are detailed in *Bulletin des Sciences Medicales*, September 1827. I have room for nothing more than his conclusions, which are as follows: "1. When a nerve has been divided, it is not sufficient for the restoration of its action, that the two portions be united by a white, cellular, interposed tissue, for this soon takes place.

2. It is necessary, that through this uniting substance nervous filaments should shoot out, and extend from the superior to the inferior portion.

3. This prolongation of nervous matter does not appear to take place until after some considerable time. The prolongations are not arranged in close contact as in the natural continuity of the nerves; but, on the contrary, they separate from each other, as though their passage through the interposed substance had been made with difficulty."—*North. Amer. Med. and Surg. Journ.* vol. v. p. 439.

OF THE SPINAL MARROW AND MEDULLA OBLONGATA.

Most light has been thrown on the development of this part, by the researches of Tiedemann.* The spinal cord always precedes the brain in formation. Malpighi observed a fibril anterior in its appearance to the heart. This central fibril seemed to him to be the spinal marrow, which he therefore regarded as the origin of all the parts.

In the fœtus of six weeks, we find a canal formed by a vesicular membrane, the pia mater, containing a grayish white fluid, at the upper end of which are the vesicular enlargements corresponding to the brain. The fluid in this membranous canal, towards the end of the second month, is converted into a soft and pultaceous mass. The parietes are formed by the dura and pia mater, which last exhibits numerous vessels. The pia mater dipping into the pulp at the anterior surface of the canal, gives rise to the anterior longitudinal furrow or sinus of the spinal marrow. Fibres are not perceptible in the structure of the part until the fourth month of fœtal existence. There are at first no marks to distinguish the medulla oblongata from the rest of the spinal cord, except a slight anterior curvature of this latter, which is in fact continuous with the crura cerebri until the third month. In the fourth month the pons Varolii is formed, and marks the limits of the medulla oblongata. The two cords, into which the spinal marrow is divided by the anterior and posterior furrows, are subdivided each of them in the medulla oblongata into three smaller fasciculi, called corpus pyramidale, corpus olivare, and corpus restiforme.

Tiedemann has clearly demonstrated that the spinal marrow is not an appendage to the brain, but that this latter is a production, or to use the language of Reil, an efflorescence from it; and he observes, that although this opinion was previously

* Anatomy of the Fœtal Brain. Translated from the French of A. J. Jourdan, by W. Bennet. Edinburgh 1826.

advocated by the ancients, yet to Dr. Gall must be awarded the merit of having clearly proved it, in modern times. But I am inclined to think that this gentleman has not such valid claims to originality in this respect. I find in Bartholine the following language:

"We make the marrow both as it is in the skull and in the back bone, to be the beginning rather of the brain ; and that the brain being divided into two parts is as it were a certain double process or production of the marrow itself." This he gives as a new opinion of his own, he then goes on with his proof : "Which is more manifest to those that behold the anatomy of fishes, for there the head and tail of the marrow is very great, but the process of the marrow, or the brain, is very little ; [the cause whereof is that fishes use motion more than sense ; intimating that the brain or barke contributes more to sense, and the marrow itself to motion. Hence fish are dull of sense but very nimble in motion." And again, a little farther on, he says, "The lengthened marrow arises as some conceives from the brain alone, according to others from the brainlet or cerebellum. But it hath both (to speak now at a vulgar rate) for its beginning. For it arises from four roots or foundations, two of which are greater from the fore part of the brain commonly so called, two are lesser from the inner part of the brainlet or petty brain. From these united the spinal marrow seems to be constituted. *But it is peradventure a more true opinion to think that those originals are processes of the marrow itself, as was said before.*"*

I think it very properly connected with this part of my subject to introduce the words of Bartholine on the formation of the lateral ventricles, as they appear to correspond *remarkably* with the *new* views advanced by the German and French anatomists, on this subject. "The roots of the spinal marrow do penetrate a good depth into the substance of the brain; to the upper and former whereof, especially where it looks in-

* Bartholine's Anatomy, p. 136. Lib. IV.

wards, the brain being continued (now I mean the whitish and ash coloured part, by the term brain), it spreads itself every way, especially outwards and backwards, and by a little and a little wreathes and contracts its lower extremities inwards and upwards, till at last being attenuated, it doth on all sides embrace the root of the spinal marrow, with a lace a little below the place where it springs therefrom; and so forms the lateral ventricle." "But in the foremore and inner part, and whitish substance ascending from each root, and making one body called *corpus callosum*, it is carried back; and covering the middle distance between the roots, which is the third ventricle, and the wide mouths of the lateral ventricles opened thereinto, formed by itself, it makes the Fornix arch or vault; and is continued to the hinder and inner part of the limbus or edge of each ventricle." "The anus is nothing but the space arising upon the mutual contact of the four trunks of the spinal marrow." His language also with regard to the manner of dissecting the brain is, I think, entitled to a place here, as it is strictly applicable to the divided opinions and practice of the anatomists of the present day. "Some with Galen, Vesalius, and Fallopius, intending to contemplate what is contained in the brain, begin their dissection in the upper part and proceed to the lower, and therefore do unfitly propound and explain many parts. I, treading in the steps of Constantinus Varolius, shall take quite a contrary course, yet such as is *true* and *accurate*, beginning at the lower part of the brain and so passing to the uppermost, and I shall afterwards propound the order of parts from top to bottom, for their sakes that will needs follow the *vulgar* and *common way of dissection.*" p. 136.

Waving all descriptions of its bony case, and membranous envelopes, I shall here content myself with speaking of the spinal marrow, in reference to its external form, and its being the origin or point of insertion, as the case may be, of the nerves. It has already been intimated that the spinal portion of the nervous system, properly includes both the me-

dulla spinalis and medulla oblongata, which are in fact continuous, and properly one, as stated by Bartholine, in the passage before cited. It is not a prolongation of the encephalon, but rather the root, from which branch and expand the crura of the cerebrum and of the cerebellum, the tubercula quadrigemina, eminentiæ mamillares, optic beds, and corpora striata. The spinal cord extends in the adult, from the occipital foramen to the middle of the first or second lumbar vertebra. Its consistence is firmer than the encephalic portion, and less so than the tuber annulare; it is more consistent in the child than in the adult, and greater in man than in woman. It is not regularly cylindrical in form, but on the contrary presents three distinct and considerable protuberances. The first is the *superior bulb* or *cephalic portion*, beginning at the medulla oblongata: the second is the *cervical* or *brachial*, extending from the third to the fifth and sixth cervical vertebræ: the third or *lumbar* enlargement, is between the ninth and tenth dorsal vertebræ. Below this the medulla becomes fusiform, and often ends in a point.

All of the nerves which originate from the spinal marrow, have a double origin, and a ganglion at their posterior root. The anterior root is composed of much smaller filaments than the posterior; a difference this prevailing throughout the whole column. The second or brachial enlargement of the medulla, corresponds with the large and numerous nerves, forming a plexus going to the upper extremities. The third or lumbar swelling answers to a similar plexus supplying the lower extremities. Tiedemann joins Gall so far in opinion as to admit the exact proportion between the volume of the spinal nerves and the enlargement at their roots.

Functions of the Medulla Spinalis and Medulla Oblongata.

The importance of the functions of the spinal cord may be conceived from this part being found in nearly all animals, in some form or another; and the more perfect, the more entire

and complete their organization. By means of its nerves it presides over voluntary motion and sensation, and in consesequence of its connexion with the brain, it becomes the agent for the transmission of the acts of volition. In addition to this, we find the influence of the spinal marrow extending over the most important of the internal phenomena of life; viz: the circulation and respiration. Here the fact is worthy of notice, that the movements of the spinal marrow, as well as those of the brain; are isochronous with those of respiration. Le Gallois had noticed that the great sympathetic had its roots in the spinal cord, and Weber has since remarked that the development of the former is always in proportion to that of the latter. Hence Rachetti has advanced the opinion of the spinal marrow chiefly presiding over nutrition. To the suppositions of Chaussier and Flourens, I can only allude on this occasion. The first thought caloricity, or the function of developing caloric, resided in this part. The second that it unites or combines the various movements of the body, establishing what he calls general sympathies. I shall restrict myself to an enquiry into the more direct specific functions of the spinal marrow, as presiding, by means of its nerves, over sensation and motion.

The name of most authority on this subject is Mr. Charles Bell. He divides the cord into two grand parts—right and left—each of which he subdivides into three others, Anterior, Middle, and Posterior. To the anterior column he assigns the function of motion, to the middle, of respiration, and to the posterior, sensation, as might have been inferred from what has been said above of the nerves. The anterior and posterior extend up into the brain, and are lost in it; the middle terminates in the medulla oblongata, and in its functions is independent of reason, and capable of its office when separated from the brain. The nerves going out from these columns, correspond, of course, in function with them. Mr. Bell found that by irritating the posterior roots of a spinal nerve, no consequent motion could be produced, but on irritating the anterior roots,

there were corresponding motions of the muscles, supplied by these nerves. Magendie confirmed the above by experiment. Having given Nux Vomica, the peculiar property of which is to excite powerful convulsions, to an animal, he divided the posterior roots of the spinal nerves. The limb was convulsed; but on dividing the anterior roots, it remained perfectly motionless, amidst the general disturbance of the other parts. He also observed, that the lateral portion of the spinal marrow might be destroyed, by thrusting a stilet up the canal, without impairing sensation or motion.

Bellingeri, a young Italian physiologist, whom we have quoted before, differs somewhat from Bell and Magendie in his results. He maintains, "that the posterior roots of the lumbar and sacral nerves determine the extension, and the anterior the flexion, of the hind legs; that the former alone preside over the sense of touch, and that the posterior columns relax the sphincter of the bladder, and contract that of the rectum, whilst the anterior columns exert just the opposite influence over the two sphincters. He limits the sensitive power to the cortical matter contained in the very substance of the cord. But Magendie's experiment, mentioned above, is at variance with this. Whatever may be the difference between these three gentlemen in other respects, they all agree in one thing,—that the posterior roots convey sensible impressions. In proof of this, a strong case is related by Magendie. A man who had lost the use of his arms, but retained perfectly their sensibility, exhibited, on post mortem examination, the posterior roots of the nerves forming the axillary plexus entire, whilst the anterior roots were reduced by the loss of their medullary matter, almost to the state of a mere membranous covering. The same author* relates two other cases, still farther corroborative of his position. The first is that of a man who died at Charenton, aged sixty-six. During the last seven years of his life, his organs of motion had been paralyzed; but those of sensation re-

* Journal de Physiologie Experimentale, Tome III.

mained uninjured; his intellectual faculties were almost annihilated, and his excretions were all involuntary. Thus reduced, he died. On opening the body, the pyramidal and olivary bodies were found pulpy, and of a dirty gray colour. The same change was observed along nearly the whole of the anterior surface of the spinal cord, and penetrating through almost the whole thickness of the fibrous bundles that compose it. The abdominal roots of the spinal nerves were still visible; but their consistence was much diminished. The dorsal surface of the cord, on the contrary, and its investing membranes, were in a healthy condition.

The second case was observed by M. Rullier. The subject of it was a man who died at the age of forty-four. Up to his last hour, this person possessed great moral energies, strong generative powers, free motion of his lower limbs, and perfect sensation in his upper extremities. The arms, however, were rigid, their muscles being permanently contracted, and often painful. They were rotated inwards, and pressed to the sides of the body, from which they could not be separated, but with some considerable effort. The fore arms were in a state of uneasy pronation; the hands flexed, and all the fingers bent. On dissecting the body after death, the spinal cord, examined with care, appeared in its natural state, from its upper end as low down as the exit of the fourth pair of cervical nerves. The dorsal surface of its two lower thirds was also healthy, but between the portions named, and through a space corresponding to the branching of the eighth or ninth pair of nerves, (six or seven inches in extent,) there was a very decided alteration. The spinal cord was there so extremely soft and diffluent, that the sheath formed by the dura mater seemed filled with a true fluid, which, indeed, flowed upward or downward, as the body was inclined. A puncture being made through the sheath, a considerable quantity of fluid instantly escaped.

Notwithstanding these facts and experiments, we are induced to believe, that neither of the two orders of spinal nerves has the one function exclusively allotted to it. For when we

excite the nerves of sensation alone, or the posterior ones, there ensue contractions in the muscles to which they are distributed, though in general the movements are much stronger and more complete when the excitation is directed to the anterior nerves alone.* The special activity of function of the spinal nerves depends on the spinal cord, and not on the roots of the nerves. Magendie found that in all instances in which he experimented, except two, the irritation of the filaments, whether anterior or posterior, after their separation from the cord, produced no effect. On the contrary, if the connexion be preserved, the nearer to their insertions they are irritated, or even when the point of the spinal cord, whence they arise, is slightly touched, the consequent phenomena of motion and sensation are of much greater intensity. The principle of the peculiar action of the spinal marrow resides in its gray substance, which diminishes with age, and is much less distinctly marked in old persons, in whom we know that the energy of movement and sensibility is in a less degree than in early life. We are not yet acquainted with the part performed by the external white portion of the medulla spinalis.

Diseases of the Spinal Marrow.

The diseases of the spinal cord may be divided into those of the *membranes*, and those of its *substance*. Of the first, inflammation is viewed as the most frequent, and the arachnoid as the membrane most suffering.

I. *Arachnitis Spinalis.*† Symptoms—Head drawn backwards, posterior muscles of the trunk permanently contracted, producing opisthotonos, violent pain along the vertebral column, more acute in some particular parts of it. Post mortem appearances—Membrane thickened, and of a pearl or milky colour, having entirely lost its transparency.

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* De la Moelle Epiniere et de ses Maladies. Par C. P. Ollivier.

† Martinet's Manual of Pathology, p. 153. Philadelphia, 1828.

The inflammations of the membrane generally terminate in 1. Serous effusion. 2. Gelatinous effusion between the dura and pia mater. 3. Thickening. 4. Ossification.

II. *Amyelia*, (Beclard,) or entire want of the spinal marrow. This has never been found without the absence of the brain, and this state is called *Amyelencephalia* (Beclard). There are several cases, on record, of fœtuses, and even children born without brain or spinal marrow. Fauvel, in 1711, detailed the history of one, in which it appeared that the infant thus deformed, had been born at the full time, and had lived two hours after birth. Méry gives an account of a similar monster, which was born at the full time, and not only survived for twenty-one hours, but took some nourishment. In some cases of this nature, the nerves were distinct and entire at their origins.*

III. Instances of partial deformity of the spinal cord, by deficiency or bifurcation, are numerous, but can only be alluded to here.

IV. *Congenital Hydrorachis. Dropsy of the meningean canal of the spinal marrow*, when congenital, is characterised by one or many tumours, at various distances from each other. This disease is usually associated with spina bifida, and other vices of structure, such as inverted viscera, imperforate anus, clubbed feet, &c.: at other times hydrocephalus is present. It soon causes death, with rapidity proportioned to the size and seat of the tumour. When this last is spontaneously ruptured, death takes place with general convulsions. We are told of cures having been effected; one instance of which is related of a woman who was living in London, in 1822, and 29 years of age, who had been born with a small tumour, on the inferior portion of the vertebral column, which gradually increased to the size of a man's head. The contained fluid sometimes oozed out in small quantities from the surface. She enjoyed good health. The causes of this disease are not well

* Ollivier. *Op. cit.* p. 84.

known, nor can we say much of its treatment, except to caution against opening the tumour, or including it in a ligature. Death following its spontaneous rupture, is usually caused by inflammation of the arachnoid, extending both upwards and downwards, which gives rise to convulsions, and produces asphyxia, when it has passed the origin of the respiratory nerves. Such is the general course of things in this disease; and yet in the Journal Universel, for 1827, we find two cases of cure of hydrorachis by puncturing, the first accidental, the second by the physician.

V. *Atrophy of the Spinal Marrow.* This may be either entire or partial. Of the first we have examples in old age, and in general marasmus. The second is exhibited in curvatures of the spine, in which the pressure gradually exercised by the vertebræ at their angle, is so great as to produce complete absorption of the substance of the medulla at the corresponding part, leaving only the membrane, to preserve the connection between the upper, and lower portions.

VI. *Wounds of the Spinal Marrow.* These are most frequently caused by fractures of the vertebræ. In these cases, if the pia mater is opened, there ensues immediately a hernia of the medullary substance, which forms a small round white swelling. This in a few days becomes of a rose colour, from the injection of the sanguineous capillaries of the nervous substance; the vessels of the pia mater around the injury are also injected, and give it a reddish tint. The most usual effect of wounds of this part is paralysis in different degrees. They are generally fatal, which occurs more quickly in proportion as the injury is nearer the superior portion of the spinal marrow. Instant death from the cessation of respiration, it is well known to every medical man, follows a wound of that portion of the spinal cord contained between the occiput and first cervical vertebra. For remarkable cases of which, see Dorsey's Surgery, Vol. I. Chap. xxxvii., extracted from J. L. Petit's work, *Maladies des Os.*

VII. *Compression of the Spinal Marrow.* When this is gradually produced, it is the consequence of alteration of the osseous structure by scrofula or syphilis. It is followed by a paralysis, varying in degree, and often by general constitutional disorder.

VIII. *Concussion of the Spinal Marrow.* This may be caused by falls on the back, buttocks, or feet, or by a blow directly on the spine. Sometimes it is followed by effusion of blood between the dura mater and bone, or between the former and the pia mater; and occasionally both these membranes and the arachnoid are torn, producing a hernia of the medulla. At other times this last becomes softer, and finally, if the patient survives for any period, it is fluid. The symptoms of concussion are partial paralysis, involuntary evacuation of fæces and urine, or their retention. Convulsions sometimes supervene; and Stoll relates the case of a man who died convulsed and tetanic, in consequence of a concussion of the spine.

IX. *Effusions, bloody and serous, or Hematorachis and Hydrorachis.* The first of these is usually the consequence of external violence, and injury of the spinal column. The latter is subsequent to irritation of the arachnoid, and the serosity is abundant, in proportion to the congestion in the veins, and membranous envelopes of the medulla. Hydrorachis is often met with in persons dying of apoplexy, in which circumstances the effusion is bloody. Loss of movement and lesions of sensibility in one or more limbs follow these diseases.

Diseases of the Substance of the Medulla Spinalis.

I. *Inflammation.—Myeletis.* Symptoms—Pain referred to some point of the spine, sensation of pricking and darting in the extremities; the cervical portion being affected causes rigidity of the neck, convulsions of the upper extremities, succeeded by paralysis, disturbed respiration. Dorsal portion: trunk sometimes agitated by convulsive motions, palpitations,

high fever, greater or less dyspnœa. Lumbar portion: paralysis of the lower extremities, constipation, retention of urine, or involuntary evacuations. If chronic, there is sometimes no pain, and the paralysis of the lower extremities, rectum, and bladder, comes on gradually.

II. *Ramollissement.—Softening.*—This change in the substance of the spinal marrow, similar to that which takes place in the brain, has been regarded by Recamier as a peculiar alteration of the nervous system, and not dependent on inflammation. It is indeed true, that softenings of the substance of the medulla may exist without any apparent trace of local sanguineous congestion: but we find frequently, also, that the enveloping membranes adjoining are red, thickened, and their vessels gorged with blood, and those penetrating the organs invisible in their natural state, are now very evident. Besides this, we know that of all the parts of the spinal marrow, the lumbar enlargement is that most frequently softened and disorganised. Next to this in frequency is the cervical bulb. Now we are assured that these are precisely the two parts of the medulla, in which there exists the largest quantity of gray substance, and in which, consequently, the vessels are most abundant. Dupuy, Professor of the Veterinary School at Alfort, informs us, that in the cervical and lumbar enlargements of horses, especially the last, softening was frequent. Similar frequency of changes of this nature is seen in the gray masses of the brain: the vascularity of this portion of the nervous mass would be an additional reason for believing that ramollissement is the effect of phlegmasia.

III. *Tumours and Hydatids.* Symptoms—Severe headache, oppressed breathing, convulsions. Post mortem examinations show tumours of a tuberculous or schirrous nature, seated in the substance, or on the surface of the medulla spinalis, separating its fibres.

By authors various spasmodic and convulsive affections have been referred to spinal disease, such as tetanus, epilepsy, chorea, and hydrophobia. With regard to the second

of these, Esquirol, in a memoir on the subject, reported fifteen cases of fatal epilepsy, in all of which, he found the spinal marrow affected. The structural alterations were various: some showing hydatids, in others the membranes were injected. In the majority, the medullary substance was softer than natural, and in one, harder. In a case of hydrophobia, the membranes of the brain were found highly vascular, and great serous effusion, but the greatest marks of disease were in the coverings of the pons Varolii, medulla oblongata, and upper part of the spinal marrow, which parts are said to have formed "*one crust of entire inflammation.*" (This case is related in the London Medico-Chirurgical Journal and Review for October, 1817.) Pinel (son of the celebrated author of the work Sur Alienation Mentale) tells us of cases of epilepsy, in which the spinal marrow was found morbidly indurated: and Ollivier, the author to whom I am indebted for the major part of these remarks on the spinal marrow, states, that he has often seen the increase of density in the medulla of epileptic subjects, when the brain did not exhibit any remarkable alteration. Professor Brera has often met with inflammation of the spinal marrow, and its membranes, in persons dying from tetanus. Goelis of Vienna, has frequently found an alteration in the upper part of the spinal marrow in new born infants who had died of trismus. It must however be acknowledged that in many fatal cases of tetanus, the most careful observation could not detect any change in the part. In diseases of a febrile character, many of the symptoms have been ascribed by Ballonius to an affection of the spinal marrow. These symptoms are pain in the back, tremor of the hand, and oppression of breathing. In confirmation of this opinion, Ranchetti relates the case of a girl who died of a petechial fever which had induced coma; on dissection, evident marks of inflammation of the spinal marrow and its membranes were exhibited, and a quantity of puriform matter was contained about the cauda equina. There were also marks of inflammation in the brain and its membranes. We have rea-

son to suppose that in some abdominal disorders, such as dysentery, colica pictonum, where paraplegia or partial paralysis supervenes, the spinal marrow is affected. In a case lately published in a journal* of this city, of acute rheumatism, the spinal marrow was affected. The subject of the case was attacked with intermittent fever, at the age of fifty, having had previous good health; this attack was followed some months afterwards by ischuria, the effect of stricture of the urethra. Rheumatism in the back, neck, and shoulders succeeded to this, and finally paralysis, which soon became general, and ended in death. An examination of the body exhibited the muscles of the posterior part of the trunk of a dark red colour, gorged with blood, and easily torn; the *spinal marrow* and *its membranes* were inflamed from the fifth cervical to the eleventh dorsal vertebra.

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* North American Med. and Surg. Journal, vol. v. p. 217.

OF THE ENCEPHALON.

Structure and Functions of the Encephalon.

By this term is understood all the mass of nervous matter contained within the cranium, from the medulla oblongata on to and including the cerebral expansions. The divisions are—1. Corpora Quadrigemina; 2. Cerebellum; 3. Cerebrum.

Growth.—In the second month of fœtal existence, we see a prolongation and slight enlargement of the medulla oblongata, corresponding to what is afterwards the brain, and which at this time is only rendered visible by the action of alcohol. The part first formed is the Tubercula Quadrigemina, which are in the beginning hollow, and are only met with in the mammiferæ and in man. They are connected posteriorly with the medulla oblongata, by bands from the olivary bodies, and anteriorly exhibit a large band going to the optic nerve. Their connection with this nerve in its function of sight, has been already adverted to.

Cerebellum.—The Cerebellum also originates from the medulla oblongata, by its two lateral and posterior portions, called corpora restiformia, which, at first of a lancinated form, separate and distinct, subsequently unite, and make the vault of the fourth ventricle. At the place of the attachment of the cerebellum to the medulla, there is always an accumulation of pulpy substance, forming in man an irregularly shaped mass, toothed or serrated around the edge. This collection of cineritious, intermixed with white matter, is described under various names, such as *corpus rhomboideum*, *corpus dentatum*, &c. The quantity of cineritious substance, says Spurzheim,* from whom I borrow on this occasion, is in the direct ratio of the entire mass of the cerebellum. The primary portion or vermiform process is formed by the junction of two slips, one

* Anatomy of the Brain, 1826.

from each cineritious substance or ganglion. The junction of the Cerebellum with the corpora quadrigemina, is accomplished by the valve of Vieussens or *processus e cerebello ad testes.* In the mammiferous class of animals, the cerebellum is augmented, by the addition of a mass known variously by the names pons Varolii, tuber Annulare, or mesalobe. This annular protuberance is developed in the direct ratio of the cerebellar hemispheres, according to Gall and Spurzheim, and is formed chiefly by the returning fibres from the two lobes. It is not, as already mentioned, visible until the fourth month in the fœtus.

Cerebrum.—The pyramidal cords of the medulla are directed from below upwards, and from behind forwards, after having produced two swellings, viz: the Optic Beds and the Striated Bodies, and terminate each in a lamina or leaf, which, curved in all points of its circumference, forms the beginning of the cerebral lobes. The medullary fibres of these cords are, prior to the formation of the pons Varolii, continued immediately into the crura of the cerebrum, and can be readily discovered, traversing the optic beds and striated bodies, to be spread in a radiated manner into the lobes. The olivary, together with fibres of the restiform bodies, contribute to the formation of the posterior, and inner portion of the cerebral crura. This last is intimately connected with the quadrigeminal bodies. It is while passing through the transverse fibres of the pons Varolii, that the pyramidal cords, with their longitudinal fibres going through gray matter, are reinforced and enlarged. But the principal ganglia of supply are the optic thalami and the corpora striata, which are in size proportionate to that of the cerebral lobes dependant on them. Space is not allowed for speaking of the convolutions of the brain, nor of their precise mode of formation.

It is worthy of remark, that the pyramidal bodies do not send fibres to form the cerebrum from the sides corresponding to themselves. There is what is called a decussation, presenting, when the decussating cords are numerous, an appearance much resembling *plaited straw.* This peculiar arrangement,

at first described by Mistichelli, in 1709, and afterwards by Petit, has been, of later years, most insisted on by Gall and Spurzheim. It is a point of much importance in physiology and pathology, and serves to explain why an injury on one side of the brain shows its effects on the opposite side of the body. Though this is a point by no means clear, since exceptions both ways are not unfrequent. When the hemiplegia takes place on the same side with that of the alteration of the brain, the latter is said to exist in the extreme end of the posterior lobe, formed by the olivary bodies, which do not in their course interlace, like the pyramidal ones. But even this is not of uniform occurrence. In addition to the *diverging* fibres, from the pyramidal bodies through the pons varolii, forming the crura cerebri, entering and reinforced in the cerebral ganglia, or the optic beds and striated bodies, and finally expanded into the hemispheres, there is another order of *converging* fibres. These meet and form what Gall and Spurzheim call commissures, or apparatus of union. The chief of these are the corpus callosum for the cerebrum, and the pons Varolii for the cerebellum, and each of these commissures is in direct proportion to its corresponding hemispheres. In addition to these are the anterior and posterior commissures, and fornix.

Influence of the Sanguineous System on the development of the Nervous System.

The spinal marrow is produced by the intercostal arteries, the cerebellum by the vertebral, the cerebrum by the carotid. As these vessels are distinct and formed at different times, so will be the order of development of the different parts. The rudiments of the spinal marrow, are prior in formation, as its arteries are first evolved, the crus cerebri and tubercula quadrigemina are next formed correspondently with the production of their arteries, and the cerebellum is developed last, as the vertebral arteries which form it arrive last in the cranium. The reason of the direction of these parts will be

perceived, says Serres, if we consider the direction of the arteries. The vertebral being directed from behind forwards, the cerebellum is formed in that direction. The carotids after doubling the cavernous sinuses, reach the anterior parts of the brain, and proceed from before backwards agreeable to the mode of development of the cerebral hemispheres. Hence the corpus callosum is developed from before backwards, according to the gradual progress of the artery of this part: hence also the anterior part of the fornix follows the same direction, while the posterior part, developed by the posterior cerebral artery, a branch of the vertebral, is formed from behind forwards.

Functions of the Encephalon.

Of the three divisions of the encephalon, the first or tubercula quadrigemina, at least the two anterior bodies, appear to be confined principally in function to the sense of sight. I shall therefore proceed to consider the other two divisions, and first—

Functions of the Cerebellum.

Authors have assigned different offices to this organ. By Vestingius* it was made the seat of memory; by Gall the organ of physical love or amativeness; by Bell, Foville, and Pinel Grandchamp, of sensibility. Magendie assigned to it the function of forward movements, Rolando that of motion, and Flourens the regulator of motion.

The opinion of this last gentleman, from the apparent plausibility of his experiments, and the favourable report made on them by a Committee of the French Academy before whom they were repeated, will engage our notice for a while. The following is a brief sketch of his inferences:

When the cerebellum is sliced in successive layers, the re-

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* *Vestingius' Anatomy*, page 59. London 1677.

moval of the first layer produced great weakness and hobbling gait: ablation of the middle layer caused the animal to stagger much, and to assist itself in walking with its wings: the sections being continued deeper, its efforts to walk or fly were in vain, and the slightest touch tumbled it over. When the whole cerebellum was removed, it was unable to stand even with the aid of its wings and tail, and made violent efforts to rise, but only rolled up and down; then fatigued with struggling it remained a few minutes at rest on its back or belly, and then again commenced its ineffectual efforts to rise or walk. Yet during all this time, its sight and hearing were perfect, as was evident from its being affected by the slightest noise, and shrinking from the blows with which it was threatened. In all these efforts and struggles there was not the slightest appearance of convulsions. Flourens thinks, that the cerebellum is the regulator of motions, or, in other words, the organ for associating and regulating the muscular contractions previously combined by the spinal cord so as to produce standing, walking, running: and that neither the cerebral or cerebellar lobes possess the power of exciting muscular contractions: this power is limited to the tubercula quadrigemina, medulla oblongata, and spinal marrow.

As might naturally have been expected, the inferences of Flourens have been disputed by the celebrated Dr. Gall, of whom I shall speak presently. Confirmation would seem, however, to be afforded to them, to a certain extent, by the still more recent experiments of M. Bouillaud. This gentleman had been a partisan of Gall, but upon the appearance of Flourens's work resolved to experiment for himself. In place of using a cutting instrument he cauterised the cerebellum, thereby preventing the hæmorrhage, which, from its weakening, had been urged as one of the chief objections to the experiments of Flourens. He touched the posterior median portion of the cerebellum with a hot iron. The animal (a dog) had a peculiarly astonished look of the eyes, walked in a staggering manner, going sometimes to the right, at others to

the left, when it wanted to go the reverse of these directions. When it desired to go forwards, it moved backwards. The animal was completely sensible, able to move its eyes, to chew, to swallow, and to regulate the larynx, &c. Bouillaud made a great many experiments of a similar nature on different animals, from which he comes to the conclusion, "That the only constant pathognomonic phenomena resulting from these organic lesions, are disorders of the functions of locomotion or equilibration. These are more remarkable, as they are unaccompanied by paralysis or convulsions. The animals could flex and extend their limbs in any direction, and with uncommon celerity and force, whence it follows that we must admit, in the cerebellum, a power that presides over the associated movements, which compose the acts of station, and locomotion; a power which is essentially distinct from that which governs the movements of the trunk of the body and members, while there exists between these forces the most intimate connection."* The author then confirms Flourens's inferences: but the latter erred in supposing *all* voluntary muscular motions were co-ordered here, for deglutition, and some movements of the trunk, appear not to be under the influence of the cerebellum. Bouillaud also found that simple irritation of the cerebellum excited motions resembling epilepsy, which may be recovered from; but the organ being destroyed, the balancing power was lost entirely. In no case was pain evinced from these lesions, nor were there any signs of erection or excitement in the genital organs. Hence he infers that the cerebellum is neither the focus of sensibility nor the organ of propagative instinct. But M. Serres concludes from numerous facts, that the median lobe of the cerebellum, is the seat of the faculty of the instinct of propagation.

Dr. Gall, immediately upon the publication of Flourens's experiments, replied to them, by opposing powerful objec-

* North American Med. Journ. vol. v. p. 197.

tions to the mode in which they were performed, viz. by vivisections; and these objections are of considerable weight.* Thus it is impossible to open the cranium, and cut the meninges so as to expose the encephalon, without causing hæmorrhage. And again, the course of the diverging fibres of the cerebrum and cerebellum, from below upwards, and of the converging from without inwards, is such that horizontal slices of these bodies must interest very different parts, and produce effects throughout the entire structure, down to the medulla oblongata. Supposing, what is now generally admitted, that different parts of the brain have different functions, these parts do not lie in a horizontal position one above another. Such an arrangement would be entirely at variance with our knowledge of the anatomy of the cerebrum and cerebellum. The relative position of the white and gray nervous matter is of itself an insurmountable objection to our drawing inferences from horizontal slices. As regards the shock communicated to the whole brain, by mutilations of a part, and the consequent hæmorrhage, the language of Gall is strikingly appropriate. "Let us reason in the style of M. Flourens: I exhaust a man by bleedings; all the functions of the cerebrum, cerebellum, medulla oblongata and spinalis, heart, lungs, and stomach are enfeebled. I cut off his head, and I kill him with a single blow; the functions of all the above-mentioned parts cease. Hence the faculties of feeling, thinking, seeing, hearing, tasting, smelling, moving, breathing, digesting, circulating the blood, secreting bile, &c. reside in the same organ."†

The facts, however, both physiological and pathological, adduced by a number of physicians and surgeons, go far to favour Gall's opinion with regard to the functions of the cerebellum.

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* Sur les Fonctions du Cerveau, vol. vi. Paris, 1825.

† Op. Citat. Tom. vi. p. 260–1.

Functions of the Cerebrum.

This division of my subject, by far the most interesting, from its important associations and connections, is at the same time one concerning which no little obscurity still exists. It is, however, consoling to reflect on the advances which have been made in this department by modern physiologists.

The general proposition that the brain is the organ of the mind, and the material instrument of thought, is now generally admitted among physiologists, and is proved by the strongest evidence, both positive and negative. Positively, 1. By the loss of thought and volition attendant on injuries or removal of the cerebrum. 2. By comparative anatomy: the volume of the cerebrum being developed in animals, not in ratio to the bulk of the body, the volume of the nerves, or the perfection of the senses, but to the degree of intelligence. 3. The intellectual powers are increased or diminished, according as the brain is matured, enfeebled, or altered. Its volume, particularly the frontal portion, is in relation to the degree of intelligence, as is universally seen in all those individuals who have been remarkable for general greatness of mental powers; and conversely, idiots have the head preternaturally small, or greatly altered in its structure by disease. Negative proof is furnished in the circumstances of the brain not being indispensable to the functions of organic life, and in acephalous fœtuses, and animals deprived of their heads, living and growing: also in the superior parts of the hemispheres having been destroyed, and also their great commissure, by disease, without the loss of life of the organic functions. All parts of the body may be injured, the nervous mass of the vertebral column may be compressed or altered, at a certain distance from the cerebrum, without weakening the affective and intellectual faculties. In tetanus, notwithstanding the other parts of the nervous system may be affected in the most violent manner, the functions of the mind remain unimpaired even until death.

Various objections have been made to the above propositions. 1st. By Buffon it has been asserted, that the Ourang Outang has the same brain in every respect as man, and not the same intelligence; therefore, we are to seek for the cause of intellect elsewhere than in this organ. But this assertion is not correct; for the brain of this animal is very different from that of man; its cranium is scarcely as much developed as that of a young child or idiot; its front is retreating. Even Shakspeare speaks

> Of apes,
> With foreheads villainous low.—*The Tempest.*

This objection is therefore destitute of any weight. 2d. That lesions of the cerebrum have not been followed by injury of the intellectual faculties. In reply to this it may be said, that before a person could be enabled to determine satisfactorily this point, he should be well acquainted with the number and nature of these faculties, which exacts a long and attentive study, and specify the precise part and extent of the injury or alteration of the organ. But waiving this, the objection may be set aside, by stating that there are numerous instances of lesions of the cerebrum being followed by loss of mental power; and where this does not occur, the circumstance may be explained, by the fact that the brain is a double organ consisting of two halves, corresponding in structure and functions, so that one being injured, the other continues to perform the joint office of the two, just as occurs in the other double organs, such as the eye, the lungs, or the testes; and in such cases the remaining organ often acquires additional power, to make up for the loss of its fellow.

To the assertion that a voluminous brain is always the accompaniment of great intellectual powers, a distinguished physician of our own country,* Dr. Warren, of Boston, objects,

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* Comparative View of the Sensorial and Nervous Systems of Man and Animals. Boston: 1822.

that we often see stupid people with large heads, and sensible men with the head small; and adds, that from numerous opportunities which he has had of examining the brain of people in this country, remarkable for their talents, he found it to be the case in some instances, but that about in an equal number, the reverse occurred, and that one individual, distinguished for the variety and extent of his native talents, had an uncommonly small brain. But this objection can only be met by entering into details of organology, which would show that the faculties of intellect, numerous and diversified as we know them to be, are only exercised by a portion of the brain, small in comparison to the entire mass, which portion may be well developed and the other portions the reverse. In addition to the circumstance of size, vital energy or temperament has also its effect, and exercise may render a small cerebral development equal in efficiency to a large brain, which, uncultivated, has been suffered to "fust unused." Again, many cases of large development and not corresponding intellectual power may occur in patients of a lymphatic temperament, or of hydrocephalic enlargement in infancy. Besides this, "we are in the practice of expressing ourselves very vaguely respecting a person's talents, which are often confounded with attainments. A cistern is often mistaken for a running stream—a specious retailer of the Encyclopœdia for a man of an original and inventive mind." Shakspeare, who, from his accurate and correct observation of things, is considered legitimate authority, appears to have been sensible of the connexion of bodily development with that of the mind, as in this passage—

> For Nature crescent does not grow alone,
> In thews and bulk; but as this temple waxes,
> The inward service of the mind and soul
> Grows wide withal.
>
> *Hamlet.*

Milton also speaks of the "fair large front of our first parent."

3d objection. Hydrocephalus prevailing with some retention of the mental faculties.

This disease has been considered a destruction of cerebral substance, by Duverney and others; but Dr. Gall's researches into its nature are sufficient to set aside this objection. He asserts that it consists in a dropsy of the ventricles; that the cerebral fibres forming the convolutions, which are naturally vertical, become horizontal, and the convolutions, the two sides of which in health are in apposition, are spread out into a serous bag. Now, mental manifestations do not depend on the direction of the fibres, which alone is changed without any loss of cerebral substance; and this change is brought about so gradually, that the organ can accommodate itself to the state; but let there be effusion of fluid suddenly, as occurs in apoplexy, and we shall soon see coma and abolition of intellectual manifestations supervene.

It has always been admitted, says Spurzheim,* that the mind is not strictly an unit, but evinces its operations by several different modes, called *faculties*. The Grecian sages speak of a mind for plants, one for animals, and one for men, and draw a distinction between vegetative mind and sensitive mind. Plato spoke of a rational and irrational mind. The Romans called the principle which gives life and sensation, *Anima;* the cause of inclinations and sentiments, *Animus*; and the intellectual and reflecting agent, *Mens*. In fact, there is no physiological or psychological system, ancient or modern, which has not admitted different faculties. Saint Augustin speaks of faculties common to man and animals, and of others that are peculiar to man. Mallebranche admits two fundamental faculties, the understanding and the will; and modern metaphysicians have divided the mind into Perception, Memory, Judgment, Imagination, &c.

Efforts have also for a long period been made to locate the mental faculties. The rational mind was located in the head, and the irrational in the viscera. The ventricles have always been deemed of great importance. The Arabians located Com-

* Observations sur La Phrenologie, p. 60. Paris: 1818.

mon sense in the anterior, Imagination in the second, Judgment in the third, and Memory in the fourth ventricle. For a long period the cerebrum was considered the organ of perception, and the cerebellum of memory; and it was believed that the degree of this latter could be determined by the size of the occiput. The celebrated French philosopher, Descartes, assigned to the Pineal gland the distinguished honour of being the seat of the soul.

Albert le Grand, Archbishop of Ratisbon, in the thirteenth century, pictured a head, and indicated upon it the seat of the different faculties of the mind. He located common sense in the front or first ventricle, judgment in the second, and memory and motive power in the third ventricle.

Pierre de Montagni, in a work published in 1491, represented upon a head the seat of *common sense*, an *imaginative cell* or portion, a *cogitative*, a *memorative*, and a *rational* cell.*

Willis, the celebrated English physiologist, located imagination in the corpus callosum, perception of sensations in the corpora striata, and memory in the cerebral convolutions. He also divided the functions into voluntary and involuntary, and he made the nerves to come from the cerebellum, which are distributed to the organs whose functions are performed involuntarily, and those which arise from the cerebrum, to go to organs which perform functions under the control of the will.†

It will be seen from the above, that attempts have long been made to determine the number and location of the mental powers; but all were based on purely hypothetical reasoning. It was reserved for the celebrated German anatomist and physi-

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* It would be well if those who speak of the want of originality of the system of Gall and Spurzheim, were just to indicate how they became possessed of their information, and we should discover that it was obtained from the works of the very men whom they censure as plagiarists.

† Portal. Histoire de l'Anatomie et de la Chirurgie, vol. iii. p. 102.

ologist, Gall, to show, by observation and experiment, both the plurality of the faculties of the mind, and the corresponding plurality of the organs or portions of the brain for their manifestations. The system is indebted, however, to his coadjutor, Dr. Spurzheim, for its full illustration and philosophical character. It would be foreign from my purpose to enter into an investigation of the system of Phrenology, abstract reasoning and various analogy constituting no part of my undertaking; it is sufficient for me to speak of their views, so far as they are borne out by demonstrative evidence. This is drawn from comparative anatomy, from the growth of the brain in the healthy subject, from its different degrees of development in different individuals, and from the effects of morbid alterations of structure.

By these gentlemen the faculties of the mind have been arranged under two orders—*Feelings* and *Intellect*. Feelings are divided into *Propensities* and *Sentiments;* Intellect into the *Knowing* and *Reflecting* faculties. The faculties of the first order, generally, are located in the occipital, lateral, and upper regions of the brain: those of the second order, in the frontal and supra-orbital portions.

Having premised this general account of the functions of the brain, I shall now proceed to give a sketch of opinions and facts which modify somewhat the above general propositions.

I have noticed, in the beginning of this essay, a division of the encephalon into two kinds of matter, the cortical or gray, and the white or fibrous. It was hence inferred by many physiologists, among whom we may mention Mr. Charles Bell, that these parts were dissimilar in function as well as in physical character, since nature never confides one and the same function to different structures; and that disorder of the intellect may exist without any derangement of the other cerebral functions.* He therefore thinks that he is justifiable in assign-

* *Idea of a new Anatomy of the Brain, submitted for the observations of his friends*, by Charles Bell. See Potter's Med. Lyceum for 1811, page 303.

ing to the white matter, as it is similar in fibrous structure to a nerve, and gives pain and causes convulsions when irritated, an identity of function with them; and as the office of the nerves is to transmit sensations, such tracts of matter are mediæ of communication connecting the different parts of the brain; an opinion this, by the way, coinciding with that of Gall and Spurzheim, of anterior date and promulgation. To the cineritious and superficial part he assigns the functions of intellect; for as it is totally insensible, he concludes that its functions are of a different and higher nature: he says, "I have found at different times all the internal parts of the brain diseased, without loss of sense, but I have never seen disease general on the surface of the hemispheres, without derangement or oppression of the mind during the patient's life. In the case of derangement of the mind falling into lethargy and stupidity, I have constantly found the surface of the hemispheres dry and preternaturally firm, the membranes separating from it with facility."

This location is confirmed by numerous pathological observations of authors, who have written on mental alienation, and who have remarked, that it is always accompanied by more or less disorganization of the cortical substance of the convolutions. Bouillaud has given the priority of this location to M. M. Foville, and Pinel Grandchamp; but as the work of Mr. Bell was published previously, viz: in 1811, the originality of it must be awarded to this last gentleman, with such reservations as the reader may think proper.

I cannot forbear inserting another passage from the often quoted Bartholine, from which it appears that Mr. Bell's ideas are not so novel as he may suppose. "Now I am of opinion, that in the brain, properly so called, or the rinde, is contained animal spirits for *sense;* and in the whole marrow, head and tail, spirits are kept for motion."

Bartholine claims the merit of novelty for this opinion, and if we keep in mind that by the term brain he means the cortical part only, it is essentially Mr. Bell's *new idea.*

I shall now go on to speak of the functions assigned to particular portions of the brain.

By two laborious experimenters mentioned above, M. M. Foville and Pinel Grandchamp, in an essay on the special seat of the different functions of the nervous system, the following inferences are given as the result of their inquiries: 1, That the brain is the seat of intellect and motion. 2, That the *corpus striatum* and medullary fibres, corresponding to this nervous mass, preside over the motions of the leg. 3, That the *optic bed*, and the medullary fibres to which it corresponds, that is to say, those of the posterior lobe, keep under their dependence, the movements of the *arm*. 4, That complete hemiplegia follows an injury simultaneously, and equally affecting the parts presiding over the movements of the arm and leg; and that partial hemiplegias, or those which affect the arm and leg unequally, depend on the alteration not being carried to the same extent in the corpus striatum and optic beds.*

Bouillaud, from a number of pathological observations, thinks that he is entitled to state the following positions: 1st. Inability to utter articulate sounds, is caused by lesion of the lower portion of the anterior lobes of the brain. 2d. Paralysis of the lower extremities occurs simultaneously with lesions of the middle lobules, or those of the corpus striatum. 3d. Paralysis of the superior member is the effect of a lesion of the optic beds, or the posterior lobules of the brain.† The conclusion of this author is worthy of remark, that the lower portions of the anterior lobules of the cerebrum, are the organs for the formation and memory of words, or the principal signs representative of our ideas. Pathology here is in accordance with the physiological observations on the strength of which Gall and Spurzheim were led to infer, that the

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* Broussais' *Physiology applied to Pathology*, translated by Drs. Bell and La Roche. Philad. 1826.

† Bouillaud. *Traité Clinique et Physiologique, De l'Encephalite*. Paris, 1825.

organ of verbal memory and talent for acquiring languages was placed in this part of the cerebrum. Loss of speech has been attributed by some to mere paralysis of the vocal apparatus, but it is worthy of note that this paralysis proceeds from the same cause as the loss of the power of forming words; so that nature has ingeniously placed together the principle of the formation of words, and the principle which puts in action the muscular apparatus destined to convert those interior signs into exterior signs or *words*. Animals do not speak because they are destitute of this internal organ.

It is in the anterior lobes that Gall and Spurzheim have located the faculties of the intellect. Of these, *perception of things* and *circumstances*, *harmony of sounds* and *colours*, *combination of numbers*, and *outline of forms*, are manifested by the lower frontal region; and *comparison* and *causality*, or powers of analogical and causative inquiry, are evinced by the development of the upper portion.

Pathology of the Encephalon.

The diseases of the encephalic apparatus, since it may be regarded as a congeries of organs, are the most important and distressing of all afflictions. During their operation the mind is dethroned, and man is rendered the melancholic or raving maniac, the helpless paralytic, or the miserable epileptic.

As these diseases are so numerous, and in reference to an inquiry into all their causes so intricate, I shall pass over the greater part of them, in order to treat of the more directly evident structural alterations of the encephalic mass, and their symptoms. Of these the chief is inflammation. The phlogosis is of two kinds. 1. In the membranes. 2. In the substance. Of the first of these, notwithstanding its importance, my restricted limits prevent me from speaking more than incidentally, in so far as it is connected with the second.

I shall therefore take up the consideration of the second

head, viz: diseases of the substance of the brain. The principal ones are the following:

Inflammation. (*Encephalitis, cerebritis.*) The parts which are most subject to inflammation, are the cineritious or most vascular part, including the corpora striata, optic thalami, convolutions, pons varolii, and cerebellum.

Symptoms. These vary with the stage; in the first period, or that of irritation, there is an exaltation of the intellectual, sensitive, and locomotive faculties. Hence headache, irritability of the eyes and ears, delirium, convulsions, countenance frowning, distorted, and animated; eye rolling, pupil contracted, painful prickings of the limbs, which are contracted, and trismus. Gradually the irritative period abates in intensity, and is succeeded by the second period, or one of collapse. In this last, which is that of disorganization or compression, there is on the contrary a diminution or total loss of the above functions. Hence coma, obtuseness of the senses, weakness, paralysis, the muscles falling into this state with flaccidity, countenance destitute of expression, eye closed, but from relaxation of the muscles which elevate the lid, falling of the lower jaw; the commissure of the lips, hitherto contracted and drawn to one side, relaxes; pupil dilated, sensibility of the affected side totally lost, and understanding completely destroyed. If the affection be general, all the functions are simultaneously disordered; when partial, the function over which the part affected presides, alone is injured, hence partial paralysis.

Post mortem Appearances. In the first period the cortical substance is found of a rose colour, the white or fibrous of a violet, and both are injected, tumefied, and slightly indurated; and may be compared to the state which characterizes erection; when cut into it appears studded with red points, called by the French pathologists *sablée du sang*, sanded with blood. It is at all times very difficult to distinguish the difference between arachnitis and encephalitis. We may presume that the former seldom lasts any time without producing the latter. In

a more advanced stage of encephalitis, and we may add of arachnitis, we meet with that peculiar state called ramollissement or softening, and as this termination of inflammation is new in medical writings, and highly important in itself, I shall give it a separate consideration.

Ramollissement du Cerveau, or Softening of the Brain.—By this term is meant a softening or semi-liquefaction of the cerebral substance. This affection was noticed by the celebrated Morgagni, and received its appellation from Rochoux, a French surgeon. But little attention, however, was paid to it, until the late interesting researches of M. M. Rostan and Lallemand, in France, and Abercrombie, in Scotland,* brought it into notice.

Symptoms. Fixed obstinate pain in the head, sense of weight, giddiness, dulness of intellect, and peevishness. A local pain is not always complained of, and the above symptoms may proceed from other causes; but a certain diagnostic is a sensation of girding, as if the brain were too large for the cranium. The senses depraved indicate a circumscribed form of the disease. A sense of formication or creeping of ants, numbness or stiffness of the upper extremities, difficulty of prehension, all indicate more profound and extended lesions. Delirium, fatuity, or any form of mental alienation, show a more advanced stage, evidencing that the process has commenced, which terminates in pulpy disorganization of the organ; and if severe lancinating pain exist, it is considered by Rostan as a certain sign that softening is going on. But there are two symptoms, which are considered as unerring diagnostics of this complaint. The first is common to this, with some other cerebral affections, and is the *smoking symptom*, (*fumer la pipe.*) When half the face is paralysed, the air expelled from the chest at each expiration, raises and distends

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* Edinburgh Medical and Surgical Journal, vol. xix. 1823. Review of Rostan and Lallemand. *Idem.* vol. xiv. 1818. Abercrombie. Chronic Inflammation of the Brain.

the chest, and in its escape produces a sound like that made by smoke when issuing from the mouth. It is a very bad symptom, and one which I have myself observed in patients in the Alms House, where it is always considered a mortal one. The other is peculiar to *ramollissement*. It is the *mouse smell sign:* in some cases of this disease the head of the patient exhales an odour quite similar to that emanating from the animal from which this symptom derives its name. It is of rare occurrence, having been only observed twice by Lallemand; but it is of fatal augury, there being no instance of recovery when it is present. The constitutional symptoms are similar to those said to pertain to adynâmic or low fevers.

Causes. Different opinions are maintained on this subject. Professor Recamier contended, as already mentioned, that it is a disease *sui generis*, a peculiar degeneration analogous to certain alterations of the spleen, and that it is not produced by inflammation, but a general cause, a disease of the whole system, an ataxic or malignant fever, which attacks the nervous structure, deranging its organization. Lallemand, Rostan, and Abercrombie, on the contrary, assert that it is essentially inflammatory in its nature, and identical in its effects with what occurs in other organs, which produces ramollissement, as in the mucous membrane. Rostan says that as an evidence of its inflammatory origin, it is generally preceded by redness and fixed acute pain, but he thinks there are cases which cannot be referred to this cause, hence he makes two divisions: inflammatory and non-inflammatory disorganization. Abercrombie, in his late publication on this subject, reconciles these differences, and coincides with Rostan in dividing ramollissement into two kinds. 1st, it is inflammatory, and is generally found in young and plethoric subjects; the 2d proceeds from disease of the arteries, is not inflammatory, and generally occurs in persons advanced in life. He thinks that softening is analogous to gangrene, in other parts of the body, and like this may originate from two very different causes—inflammation, and the failure of the circulation from

disease of the arteries. For additional arguments in favour of its inflammatory character, I refer to what was said on softening of the spinal marrow.

Post Mortem Appearances. There is found a species of liquefaction occurring in part of the structure, while all the rest preserves its consistence: the altered portion becomes loose, pulpy, and semi-fluid like custard (bouillie). If submitted to the microscope, it will be found to possess no longer the qualities of healthy cerebral substance. But there are various stages in this process. In the early period of the disease, the cerebral substance is not entirely gone, but a more fluid matter is disseminated through it, which appears to be a part of the brain broken down, and not a new secretion. In a more advanced stage it resembles thick bread pap; in the last period the cohesion of cerebral substance is so altered as to have become a homogeneous pulp. With this change of consistence, there is also a change of colour, which, according to Rostan, may be yellowish, greenish, rose colour, chestnut, like wine lees, or of a dull white, but never that of healthy brain. This difference of colour is not owing to distinct disease, but to its locality, being reddish in the cineritious, and yellowish or greenish in the fibrous substance, owing to the difference in the number of the vessels received by either. As regards the situation of ramollissement, any part is liable to be affected, but the regions most subject to it are the corpora striata, optic thalami, the central part of the middle lobes of the hemispheres, the cerebellum, and the cerebral prolongations. It is said to occur generally in corresponding portions of the brain, to those affected in true apoplexy. Of 41 cases of this last mentioned disease, examined by Rochoux, 28 were seated in the corpus striatum and optic thalami, 7 in the middle portions of the hemispheres of the cerebrum, 3 in the posterior parts, 2 in the anterior, and 1 in the middle lobe.

Serres fully corroborates this view in his work on apoplexy. He shows that the apoplectic seizure and the subsequent he-

miplegia or partial paralysis, are not so often as supposed the effects of effusions in the ventricles, or of pressure on the brain from the blood flowing out of ruptured vessels; but that they are consequent on inflammatory action, ending in softening and caving out, as it were, of portions of the substance of the brain. Dr. Physick, in his inaugural thesis, (*De Apoplexia*) printed at Edinburgh in 1792, intimates very clearly his doubts of apoplexy being a result of gradual compression of the brain; and he consequently thinks that distention of the blood vessels or extravasated serum can hardly be received as causes of the disease.* This is precisely the opinion of Serres, who in his work on apoplexy, written a few years ago, contends that serous, sanguineous, sero-sanguineous, and purulent effusions are owing to irritation in the meninges, or the brain, or to rupture of the arteries or veins, which may take place during apoplexy, though *subsequent* to, and as the *effect* of the *previous* irritation. He justifies the belief of a reunion of the white or fibrous part, so as to form a kind of cicatrix after a separation by softening in the ulcerative process.

The brain is subject also to chronic affections, such as encysted abscess, tubercles, and hydatids, but my limits forbid any consideration of them. For the same reason I am compelled reluctantly to pass in very cursory review a most important and interesting class of cerebral diseases, such as mania, epilepsy, &c. classed by authors under the head of Vesaniæ or Mental Diseases. I regret this the more, since by the improvements in physiology and pathology, much of the obscu-

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* He refers to some experiments performed by members of the Edinburgh Medical Society, in which the blood vessels of an animal were distended to twice their usual size without any thing like apoplexy supervening. "Experimenta haud ita pridem per aliquot sodales Medicæ Societatis Regiæ, quæ Edinburgi est, instituta, quibus vasa animalis altero tanto sanguinis supra justum numerum replebantur, unde nihil apoplexiæ insecutum est, testari videntur, vasa cerebri, in quæ periculum distendi æque, ut credere par est, atque in reliqua fuit directum, adeo tamen tuta ab eo esse seu nihil affici, ut hicce morbus inde oriri nequeat." p. 18.

rity that hung over this department of medical inquiry is disappearing. What was begun by Pinel is seconded by the labours of Esquirol and Georget, and we are now not only freed from the shackles of metaphysicians in our treatment of these diseases, but can even afford them many valuable data for their studies.

We are now very well assured that the exercise of the intellectual faculties, and of the sentiments and affections, is the manifestation of the functions of the brain. The encephalic apparatus is then the primary seat of mental disorders; and it is often the only part disturbed. It is on its lesion that insanity depends, manifested by what is called raving. This raving is always preceded, accompanied, or followed by various other very important cerebral or nervous disorders, such as wakefulness, cephalalgia, disorders of sensibility and contractility, inflammatory irritation, congestion, plethora, &c., of the encephalic apparatus. The termination of insanity serves to show still farther its seat. When the patient does not die of some accidental disease, there is a feebleness, an atony of the brain, which is manifested by a more or less complete abolition of intellect, and a state of paralysis, at first partial, but afterwards general. More than half of the insane, says Georget,* are paralytic. Hence it appears that the brain, at first affected, almost exclusively, as an intellectual agent, is finally attacked as a nervous agent. As regards causes, we are forced to admit, that, however much pathological conditions of the other organs may trouble the brain, and even produce acute delirium, yet, in the large majority of cases, the latter is the part primarily and mainly affected. Moral causes are the ones most constantly operative. We find often a period of predisposition, or more correctly, as the French writers call it, *incubation*, marked by eccentricities of conduct and manners, which is soon converted into madness, either by any violent moral commotion, or corporeal irritation.

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* De la Folie. Paris, 1820.

The divisions of insanity, as introduced by Pinel, are the most satisfactory, and accord best with the symptoms and progress of the malady. Georget's modifications are useful, and his classification is the one I shall adopt. The genera are I. *Mania.* II. *Monomania.* III. *Stupidity.* IV. *Dementia.* V. *Idiotism.* The three first are those which are more especially entitled to notice, and properly constitute insanity. *Mania* is generally characterized by delirium, or raving indiscriminately on all subjects. *Monomania* or *melancholy*, consists in fixed and morbid attention on a particular subject, with false notions respecting it; the mind being sane in other respects. This is the most common kind. *Stupidity* is defined to be an accidental absence of the manifestation of thought, either from the patient being destitute of ideas, or from his inability to express them. The exterior of the person thus affected is perfectly tranquil, and few evidences of sensibility are given. *Dementia*, or Amentia, or fatuity, is a general feebleness or abolition of the intellectual faculties, the consequence of a wearing out as it were of their organs, either by age, or mental or other diseases. It is distinguished by a lack of all reasoning principles, forgetfulness of the past, disregard of the present, and indifference to the future. The internal or vegetative life is all that is active in persons labouring under dementia. *Idiotism* is a defective development of the intellectual faculties:—it has few ideas,—some sensations and propensities. It is usually the effect of congenital deficiency, or disease of the brain. Idiotism and dementia are incurable.

Insanity is generally of a continued type; sometimes it is intermittent or remittent. Usually there are exacerbations or true paroxysms, especially in the afternoon from four to six o'clock. The remissions from the disease may be for several weeks or more.

As respects structural alterations, I shall briefly notice those of the skull and brain. Georget says, that of the large collection of skulls of M Esquirol, more than five hun-

dred in number, he found one half of them exhibited some peculiarity in form, density, or thickness. A common alteration was the disappearance of the diploe, the bones becoming very hard and white, resembling ivory, and of great density.

Changes in the brain were on the same authority observable in one half the number of cases examined. M. Georget, while insisting on disorders in the encephalic apparatus being the cause of insanity, thinks, at the same time, that we cannot expect always to find evident or material evidences of this fact. The exercise of the intellect is, he says, performed with very little motion of the cerebral fibres, for were it otherwise, insanity would not be susceptible of cure, the nervous substance rarely returning to its primitive state when once altered or disorganised to any extent.

The morbid changes in the thoracic and abdominal organs are, according to this author, entirely secondary and accidental, depending on the circumstances in which the patients are placed, and growing out of their mental condition, their kind of life, or the arrangements of the institutions in which they are confined.

Summary of the separate Functions and conjoined Operation of the different parts of the Nervous System.

The history of the growth and successive development of the nerves, shows that the minute portions of the tissue, or those expanded on membranes and which enter into the composition of the organs, are the first to be completely formed. Each nerve has its peculiar office in the organ or organs to which it is distributed, and which no other can supply. Thus, the fifth gives sensation; the portio dura of the seventh, motion to the face; the par vagum places the lungs and stomach in sentient connexion with the centre or brain. The simpler the arrangement of the nervous tissue, the more simple is the

function. In plants and some of the lower animals, it serves merely for the transmission of a few indispensable stimuli, as of light, heat, and electricity, giving very little notice of the changes in nutrition. In rather a higher class of animals, as the worms and the mollusca, we see longitudinal cords take the place of irregularly arranged corpuscles. At the upper end of these cords, and occasionally along their course, are enlargements or ganglia, which are the centres of smaller cords or twigs, going off from the main ones. This disposition is chiefly intended for nutritive life. The nerves going to the senses and locomotive organs of these animals, are smaller and direct in their course. In a large and the most important division of the animal kingdom, the vertebral animals, we find, in addition to the nerves supplying the senses and viscera with their ganglia, certain central masses contained in a bony case. These are usually called spinal marrow and brain. There is not here, as in the invertebral animals, merely a central cord and ganglia, where the nerves both of the viscera and senses meet. The organs of nutrition in the vertebral animals are supplied indeed with nearly a similar apparatus in the great sympathetic and its ganglia and plexuses, as in the classes below them. But the nerves of the different senses in particular, and of the sensations in general, and also of motion, meet at another axis, viz: the medulla spinalis, and its prolongation, the medulla oblongata. We are not however to suppose that these two systems of nerves are entirely distinct. They have a double union, 1st. in the viscera and their plexuses, as the cardiac and solar plexuses. 2d. at the spinal marrow, which receives twigs from the ganglia of the sympathetic all along the vertebral column. The complexity of functions in the vertebral animals, and especially in the mammiferous class, as of motion and sensation, is provided for by the great number of inosculations and cords meeting at the common axis or spinal marrow, and by the union of nervous branches. Of this we see instances in the provision for a suitable conveyance of nervous influence to the limbs, by the brachial and femoral plexuses. The compound nature of the

functions of respiration in the warm blooded animals, also demands and receives a numerous and diversified distribution of nerves, as was shown in a previous part of this essay, when speaking of the respiratory nerves. Anatomically examined, and studied in their physiological union and harmony of function, the different portions of the two systems of nerves, viz: that for nutrition and that for sensation and motion, are found to meet at the spinal marrow. Pathology and experiments on living animals go far to confirm this view, which we shall, after one or two remarks on the brain, attempt to enlarge on. In the vertebral animals, the termination of the spinal marrow and medulla oblongata is not in a simple knot or ganglion, but is expanded into the complex mass called brain. It is not like what is called brain in the invertebral animals—a mere centre of some nervous twigs of the eye and ear. It is comparatively late in its formation and entire development, and serves for other purposes already mentioned. By it the animal gives the necessary direction to the various voluntary movements of the body, attends to its wants, and seeks for the gratification of its desires. Though it has not an immediate nervous function or controul over the different parts of the body, it participates in all the impressions made on them, and communicates in return its feelings and orders. It is the grand centre, the seat of the last appeal in all the sensitive and contractile actions of the animal economy. But it has also higher offices in being the instrument of instinctive actions in most animals, and of reasoning and thought in the highest class, or *man*. That such are its functions, we have conclusive evidence in the variety and complexity of mental acts.

I shall close this essay, already too long, by an attempt to fix the influence the great sympathetic, the spinal marrow, and the brain have respectively and conjoined on the grander functions of organic life, viz: respiration, circulation, nutrition, and calorification.

Of the precise functions of the sympathetic nerve we know little. Reasoning from analogy we should suppose it compe-

tent to animate, as far as nerves are concerned, the organs of nutritive life or of assimilation, since it is the only nervous cord or centre in certain animals, and in the monsters without brain or spinal marrow, of the warm blooded class the viscera together with the sympathetic have been met with entire. Though not destitute of sensibility, it is of so low a grade as hardly to come under the cognizance of the sentient centre, but for the interweaving of its branches with the cerebral nerves. Wherever it most abounds, as the heart, small intestines, and liver, the sensations in a healthy and natural state are but small. Sending, as this nerve does, twigs to all the arteries of the abdomen, and to the muscular structure of the heart and alimentary canal, as also to the salivary glands, the pancreas, liver, and kidneys; we are authorized in regarding it as a grand chain to associate these various parts in the functions of secretion and nutrition. In its distribution we have a key to what is called the sympathy between the different parts of the digestive canal, and between this latter and the liver, pancreas, and urinary organs. To make use of the language of a celebrated physiologist, we may say that "the encephalic nerves establish relations with external bodies, and preside over the grander movements, as those of muscular masses for locomotion. The great sympathetic establishes in the interior of the body, relations between the viscera, and regulates their particular movements. For the exercise of this function it borrows stimulation from the encephalon, and transmits some to it at need."*

In reference to the nervous influence on the functions of *respiration* and *circulation*, I shall introduce the inferences of Le Gallois and Wilson Philip. From a number of novel and interesting experiments performed by the former, he was led to infer that the principle of sensation, motion, and respiratory movement resided in the medulla spinalis and oblongata. He proved that the latter action was influenced by the

* Broussais' Physiology applied to Pathology, p. 244.

medulla oblongata, since taking out the cerebrum and cerebellum did not affect respiration, but on removing the medulla oblongata this function ceased instantly, and on cutting off the communication with this part from below it also ceased. By destroying with a stilet the medulla spinalis, sensation and motion were both lost; the performance of the above three functions constituted, in his opinion, the essence of *life*. From all his experiments he deduced the following conclusions, which were considered as satisfactorily demonstrated by a Committee of the French Institute, who were appointed to report on them, and before whom Le Gallois repeated the principal part of his experiments.

"First: That the principle of all inspiratory movements resides in that portion of the medulla oblongata which gives rise to the nerves of the eighth pair. Second: That the principle which animates every part of the body resides in that part of the medulla spinalis from which the nerves of the part originate. Third: That it is likewise from the medulla spinalis that the heart receives the principle of its life, and of its power; but in the whole medulla, and not in a circumscribed portion of it alone."*

These conclusions have been confirmed by a distinguished anatomist of our own country, in a course of experiments performed by himself.†

Wilson Philip, from his experiments, is led to inferences more at variance in appearance than fact with those of Le Gallois. He asserts that the power of the heart, and vessels of the circulation, are independent either of the brain or the spinal marrow, for the heart continues to act when removed from the body, and in the fœtal state performs its functions when neither the brain or spinal marrow has existed; and that he has removed those parts without impeding the motion of the heart. But he admits from this organ having nerves, and

* Le Gallois on the Principle of Life, Philadelphia. p. 328.

† See Dr. Horner's Paper on this subject, in the Philadelphia Medical and Physical Journal, vol. i. p. 287.

being affected by passions, that, although independent of the nervous system, yet it is capable of being influenced through it, so as to have its action accelerated or retarded.* A powerful and beautiful illustration of the influence exercised by the brain or mind over the heart, is found in the following passage of the soliloquy of Macbeth when meditating the murder of Duncan:

> "Why do I yield to this suggestion,
> "Whose horrid image doth unfix my hair,
> "And make my *seated heart knock at my ribs*,
> "Against the use of nature."

But to resume the consideration of the opinions of Le Gallois, and Wilson Philip. Both these experimenters admit the sway which the spinal marrow exercises over the heart and the circulation. Le Gallois conceives the power to be in the nervous centre; Wilson Philip in the organs themselves, which would not however possess all their energy of function, without the nervous distribution as well from the brain as from the spinal marrow. Chemical and mechanical irritation of the brain, by various sedatives applied to it, affected the circulation and the secretions.

Of the effect of the nervous system on the *circulation*, there are many proofs, particularly over the *capillary* circulation. Fear drives the blood from the capillaries of the countenance. Anger and the pleasurable sentiments distend them. The nerves also exert a great power over the irritability of their adjacent vessels. The pulsations continuing in paralytic limbs, has induced the opinion, that arterial action was entirely independent of nervous influence. But Sir Everard Home thinks that the following experiment contradicts this. He laid bare the carotids of a dog, then irritated the nerves in the same sheath; and he found that the pulsations in two minutes were stronger, in three they were more violent, in four they were lessened, and in five minutes the pulse was restored to its natural state. This

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* Experimental Inquiry into the Laws of the Vital Functions. Philadelphia, 1818.

gentleman also observed the aorta pulsating violently in consequence of an irritation of the nerves of the urinary bladder.* But the experiment on which Sir Everard Home lays so much stress, is, I think, neither satisfactory nor conclusive, for we all know that violent muscular exertion will increase the pulse; and, in all probability, the increase of pulsations in the animal which was the subject of the above experiment, was owing to its violent struggles, when exposed to the excruciating pain attendant on the irritation of a nerve.

Of the *Secretions.* Bordeu says, that the manner in which secretion is performed is owing to peculiar sensibility of the nerves situated at the minute extremities of the ducts, by which they are capacitated for tasting, as it were, the qualities contained in the blood, admitting those suitable, and rejecting what is useless. It was also the opinion of a celebrated Swedish chemist,† that this function was dependent on nervous influence; for, says he, if you divide all the nerves distributed to a secreting organ, leaving in it the blood-vessels, secretion will be suspended. Passions of the mind will increase or diminish secretions; sight of food causes an increased flow of saliva; fear occasioned by a fall, interrupted, until the next period, the menstrual flow, in a case related by Dr. Dewees; the secretion of urine is also dependent on the nervous influence, as is proved by a German physiologist, who found that dividing the spinal cord, caused a total suppression of the urine.

Calorification.—There are many facts which go very far to prove, that the production of animal heat is influenced by nervous agency. In palsies, the temperature of the affected side is less than that of the sound one, the pulse being the same in both sides. In low or atonic fevers, in which the nervous system is seriously affected, there is great irregularity in the temperature of different parts of the body. Animals,

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* Home's Comparative Anatomy, vol. iii. p. 40.

† Berzelius, on Animal Chemistry.

in which the nervous system is most developed, have the highest degree of natural heat; a ligature or compression of a nerve produces cold and torpor in the limb supplied by it, an instance of which is familiar to every one in what is commonly called the *foot being asleep.* In a person whom Bichat saw, whose cubital nerve had been divided by a piece of glass, the little and ring fingers were uniformly colder than the rest.

Nutrition is also influenced by the nervous system, though we cannot say precisely to what extent.

In conclusion, it may be laid down as a general principle, applicable to all living matter, both vegetable and animal, that for the purposes of the secretion of various new matters, and of their deposition, constituting nutrition, as well as for the evolution of animal heat, a peculiar compound structure, consisting of a minute vessel, and nervous expansion, with intervening cellular tissue, is required; and that the large masses or centres of nervous matter are chiefly intended as recipients of impressions from without, and as governors of voluntary movement. But that in mental emotion, and in great lesions of these parts from mechanical violence or disease, they can stimulate unduly the various viscera—heart, stomach, intestines, and receive from them painful stimulations, none of which are in action during a healthy or natural state. Partial elevation of temperature in one viscus, increased local secretions, morbid nutrition of a part, all show that the nerves exert a paramount sway wherever they are distributed, without calling for additional power from the spinal marrow or brain.

On a subject so interesting and fruitful in results as the present, I might long continue to dilate,—certainly to my own instruction, if not to the benefit of others. But the measure of even a practised writer's feelings is not always a true one—of course those of a tyro must be still more liable to fallacy. In what has been said, I can with propriety claim credit for good intention, and a sincere desire to arrive at the truth. For the rest I commit myself to the candour and indulgence of my judges.

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